ORNAMENTAL BRICKWORK.

No. 43, St. Martin's Lane, London.

A

RUDIMENTARY TREATISE

ON THE MANUFACTURE OF

BRICKS AND TILES;

CONTAINING AN OUTLINE

OF THE

PRINCIPLES OF BRICKMAKING.

BY EDWARD DOBSON,

ASSOC. I.C.E. AND M R.I.B.A.

Illustrated with Ninety-two Engravings on Wood.

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REFACE TO THE FIRST EDITION.

HE preparation of this little work has necessarily ex-nded over a considerable period of time, and, although ir limits preclude anything like an attempt at a com-ete view of the principles and practice of Brick-aking, it will be found to contain much practical formation which has never yet been published, and scriptions of processes which are little known be-nd the localities where they are practised. The hole of the illustrations have been drawn expressly r the work, and the descriptions of tools and pro-sses have been written from personal observation, dependence having been placed on verbal descrip-on, even by experienced workmen. Working brick-akers are mostly illiterate men, unable to describe rrectly their own operations, and still less to explain eir meaning. I have therefore considered it necessary have every process here described carefully watched roughout, either by myself or by some one on whose curacy of observation I could place dependence.

In the course of last autumn I drew up several papers questions, embracing a variety of points on which it as found difficult to obtain correct information, but

which were distributed amongst those of my frie who were likely to have opportunities of ascertaini what was required.

Many of these papers in course of time were return accompanied by valuable details, and I have to expr my thanks and obligations to many gentlemen p sonally unknown to me, for the assistance th afforded. Amongst those from whom I have receiv valuable assistance during the progress of the work may especially mention the names of Mr. Arthur Aik Mr. John Lees Brown, of Lichfield, Mr. Willia Booker, of Nottingham, Mr. Richard Prosser, of B mingham, and Mr. Frederick Ransome, of Ipswich.

Mr. Richard Prosser has kindly contributed a valuab account of the practice of Brickmaking in Staffor shire, which will be read with much interest, and it w be worth the reader's while to compare the process described in this chapter with those made use of in t neighbourhood of Nottingham, described in Chapter II

The details given in Appendix I. respecting the manu facture of Suffolk bricks were kindly furnished by M Frederick Ransome, to whom I am also indebted f drawings of a Suffolk kiln, which were intended b him as a contribution to the work, but which, u fortunately, were committed to the post for transmi sion, and never reached their destination.

In collecting the information requisite for writing th accounts of Brickmaking and Tilemaking as practise in the neighbourhood of London, I am under great obl gations to Mr. Adams and Mr. Randell, of the Maiden

ne Tileries, and to Mr. Samuel Pocock, of the Cale-
nian Fields, Islington, for the kindness with which
ey afforded me facilities for inspecting and sketching
eir works, and for the liberal manner in which they
rnished me with details of prices and quantities.

Although much time and pains have been bestowed
on the work, there is so much difficulty in writing a
ictly-accurate account, even of a simple operation, that
cannot hope that it is perfectly free from errors; but I
ust that they are only of a trivial nature, and I shall
greatly obliged to any reader who will point out any
nissions or mis-statements, that I may be able to
rrect them in a future edition.

There has long been a want of rudimentary treatises
the Materials of Construction, published in a cheap
rm, and written in a simple and practical style,
vested of scientific technicalities, which render such
oks nearly useless to those by whom they are most
eeded. I venture to express a hope that this work may
of service in supplying this deficiency with regard to
e very important class of building materials. At the
me time it must be observed that the *science* of Brick-
aking is as yet untrodden ground, comparatively little
ing known of the manner in which different sub-
ances mutually act upon each other when exposed to
rnace heat, or of the relative proportions of silica,
umina, lime, and other usual ingredients of brick-
rths, which are best calculated to produce a sound
ell-shaped brick, of a pleasing colour. All that I have
tempted here, therefore, is to give a clear description

of the actual manufacture of bricks and tiles, and explain the leading differences which exist in the mann of conducting the several operations of Brickmaking various parts of this country. How far I have succeed in this attempt the reader alone can determine.

EDWARD DOBSON.

London, 1850.

PREFACE TO THE SECOND EDITION

Mr. Dobson's excellent Treatise having been placed i my hands for revision, I have endeavoured to maintai its usefulness by altering it as little as possible. A many of the details of the First Edition referred to th injustice and anomalies of the duty on bricks, and a that duty has been removed, such details have bee omitted, and the space thus saved has been filled wit more recent matter, including a chapter on Brick making by Machinery.

C. TOMLINSON.

London, *June*, 1863.

RUDIMENTS

OF THE

T OF MAKING BRICKS AND TILES.

INTRODUCTION.

IT would be impossible, in a little volume like the ;ent, to enter at any length upon the early history he Art of Brickmaking, nor would such an investi- on, however interesting in a historical point of view, much to our practical knowledge of the subject. ;, however, desirable that we should give a few par- lars relative to the progress of the manufacture in country; and we propose at the same time to give ief sketch of the legal restrictions which have been osed from time to time upon the mode of conduct- the operations of the brickmaker.

I. The use of brick as a building material, both burnt unburnt, dates from a very early period. Burnt k is recorded in the Bible to have been used in the tion of the tower of Babel; and we have the testi- ıy of Herodotus for the fact, which is confirmed by investigations of travellers, that burnt bricks, made ı the clay thrown out of the trench surrounding

the city, were used in building the walls of the cit Babylon. These very ancient bricks were of t kinds; one of which was very similar to the mo white Suffolk bricks, and another to the ordinary brick of the present day.

Sun-dried bricks were extensively used in anc times, especially in Egypt, where their manufac was considered a degrading employment, and, as s formed the principal occupation of the Israelites du their bondage in Egypt after the death of Joseph. V interesting ancient representations of the proce employed are still in existence, and throw much li on various passages of Scripture. Thus, the pass in Psalm lxxxi. 6, "I removed his shoulder from burden; his hands were delivered from the (*wa* pots," is strikingly illustrated by pictures still preser to us, in which labourers are carrying the tempe clay on their shoulders to the moulders, whilst oth are engaged in carrying vessels of water to temper clay. The Egyptian sun-dried bricks were made w clay mixed with chopped straw, which was furnished the Israelites by their Egyptian taskmasters before application of Moses to Pharaoh on their behalf, af which the obligation was laid on them to provide th own straw, which appears to have been a grievous ad tion to their labour. It would appear from the deta given, that the Israelites worked in gangs, under t superintendence of an overseer of their own natio who was provided with all necessary tools and mat rials, and who was personally responsible for the labo of the gangs.

Burnt bricks were, however, also used in Egypt f river walls and hydraulic works, but, probably, not any very great extent.

[t is recorded in 2 Samuel xii. 31, that David put
: children of Ammon under saws, and harrows, and
:s of iron, and made them pass through the brick-
n: without entering on the question whether the
ımonites were made to labour in the brickfields as
Israelites had themselves previously done during
: time of their bondage in Egypt, or whether we are
understand that they were put to death with horrible
tures, as supposed by most commentators, there is
:rong presumption that the implements here spoken
in connection with the brick-kiln were employed in
preparation of the clay; and if this view be correct,
passage is interesting as evidence of the use of
chinery in making bricks at a very early period of
,ory.

II. The Romans used bricks, both burnt and un-
nt, in great profusion; all the great existing ruins
Rome being of brick. At the decline of the Roman
pire, the art of brickmaking fell into disuse, but
revived in Italy after the lapse of a few centuries.
: mediæval ecclesiastical and palatial architecture of
y exhibits many fine specimens of brickwork and
ımental work in terra-cotta; cornices and other
›rations of great beauty being executed in the
ər material.

V. In Holland and the Netherlands, the scarcity of
c led, at an early period, to the extensive use of
k, not only for domestic but for ecclesiastical build-
, and these countries abound in fine specimens of
kwork, often in two colours, combined with great
ə, and producing a very rich effect, as in the cele-
ed examples at Leeuwarden in Friesland. It is
thy of remark, that in the fens of Lincolnshire and
folk, where we should naturally have expected to

have found the same material made use of, the churc many of which are exceedingly fine specimens of ar tecture, are built of small stones, said to have l brought from a great distance on pack-horses.

V. Brickmaking appears to have been introdu into England by the Romans, who used large t bricks or wall tiles as bond to their rubble constr tions; and such wall tiles continued to be used England until rubble work was superseded by regu masonry, about the time of the Norman Conqu Brick does not appear to have come into general use a building material until long afterwards.

In the reign of Henry VIII., however, the art brickmaking had arrived at great perfection, and t remains of many buildings erected about this ti exhibit some of the finest known specimens of orn mental brickwork.

The following is a list of some of the principal bri buildings erected at the period of which we speak :—

NAME.	WHEN BUILT.
Hurstmonceaux Castle, Sussex . .	Early in the reign of Henry V
Gate of the Ryehouse in Hertfordshire	Ditto.
Tattershall Castle, Lincolnshire . .	A.D. 1440.
Lollards' Tower, Lambeth Palace .	A.D. 1454.
Oxborough Hall, Norfolk . . .	About A.D. 1482.
Gateway, Rectory, Hadleigh, Suffolk .	Close of 15th century.
Old part of Hampton Court . .	A.D. 1514.
Hengrave Hall, Suffolk . . .	Finished A.D. 1538.
Manor House, at East Barsham, Norfolk	During the reign of Henry VI
Thorpland Hall, Norfolk . . .	Ditto.
Parsonage House, Great Snoring, Norfolk	During the reign of Henry VII

Many of these buildings have been engraved in Pugin' "Examples of Gothic Architecture," to which we woul refer the reader. The decorative details of the Mano House at East Barsham, and of the Parsonage Hous at Great Snoring, are particularly worthy of notice

panelled friezes, eornices, and other ornamental
:, being constructed of terra-eotta moulded to the
ired form. The use of terra-cotta for deeorative
ls and bas-reliefs appears to have been eommon
ng the reign of Henry VIII. The gateway of
: Place, Whitehall, designed by Holbein, was de-
ted with four eireular panels, which are still pre-
ed at Hatfield Peveril, Hants.

he gateway of the Reetory in Hadleigh ehurehyard
ry similar in eharaeter to that at Oxborough Hall,
aved in Pugin's work, above referred to. It has
lately restored very carefully, the terra-cotta work
he purpose being made at the Layham Kilns, near
leigh, in moulds of somewhat complieated eon-
ction.

the time of Queen Elizabeth, briek seems only to
been used in large mansions. For eommon build-
, timber framework, filled in with lath and plaster,
generally used, and this eonstruetion was mueh
loyed, even when brickwork was in eommon use,
briekwork, up to a late period, being merely intro-
d in panels between the wooden framing.

I. On the rebuilding of London after the great fire
666, briek was the material universally adopted for
new erections, and the 19th Car. II. e. 11, regu-
l the number of brieks in the thickness of the walls
he several rates of dwelling-houses. One of the
lutions of the eorporation of the eity of London,
ed about this time, is interesting; it is as follows :—
d that they (the surveyors) do eneourage and give
ctions to all builders, for ornament sake, that the
ments and projeetions of the front buildings be of
ed bricks; and that all the naked parts of the walls
be done of rough brieks, neatly wrought, or all

rubbed, at the direction of the builder, or that th builders may otherwise enrich their fronts as the please."

Much of the old brickwork still remaining in Londo in buildings erected at the end of the 17th and be ginning of the 18th century, is very admirably execute The most remarkable feature of the brickwork of thi period is the introduction of ornaments carved with th chisel. A fine example of this kind of work is show in the Frontispiece,* which is a sketch of No. 43, St Martin's Lane, one of a block of houses built by person of the name of May, who about the same tim erected May's Buildings, to which the date of 1739 i affixed. The house in question is said to have bee intended by Mr. May for his own residence. Its deco rations consist of two fluted Doric pilasters, supportin an entablature, the whole executed in fine red brick-work; the mouldings, flutings, and ornaments of the metopes having been carved with the chisel after the erection of the walls.†

VII. It was not till the close of the last century that bricks were subjected to taxation. The 24th Geo. III. c. 24, imposed a duty of 2*s*. 6*d*. per thousand on bricks of all kinds. By the 34th Geo. III. c. 15, the duty was raised to 4*s*. per thousand. By the 43rd Geo. III. c. 69, bricks were divided into common and dressed bricks, and separate rates of duty were imposed on each kind. These duties and those on tiles were as follows:—

* The author is indebted to the kindness of Mr. Edis for this sketch of one of the most interesting specimens of ornamental brickwork in the metropolis.

† The author is indebted for this information to Mr. Cannon, Foreign Bookseller, of No. 11, May's Buildings. This gentleman, who has paid much attention to architecture, took advantage of the opportunities afforded by the erection of scaffolding, at a time when the house was undergoing repair, to make a minute examination of these decorations.

SCHEDULE (A)—DUTIES.

BRICKS AND TILES.

	£	s.	d.
ery thousand bricks which shall be made in Great Bri- not exceeding any of the following dimensions, that say, ten inches long, three inches thick and five inches	0	5	0
ery thousand of bricks which shall be made in Great ain exceeding any of the foregoing dimensions . .	0	10	0
ery thousand of bricks which shall be made in Great ain, and which shall be smoothed or polished on one or side or sides, the same not exceeding the superficial ensions of ten inches long by five inches wide . .	0	12	0
ery hundred of such last-mentioned bricks, exceeding aforesaid superficial dimensions . . .	The duties on paving-tiles.		
very thousand of plain tiles which shall be made in at Britain	0	4	10
ery thousand of pan or ridge tiles which shall be made reat Britain	0	12	10
very hundred of paving tiles which shall be made in at Britain not exceeding ten inches square . . .	0	2	5
ery hundred of paving tiles which shall be made in at Britain exceeding ten inches square . . .	0	4	10
ery thousand tiles which shall be made in Great Bri- , other than such as are hereinbefore enumerated or ribed, by whatever name or names such tiles are or may alled or known	0	4	10

.B.—The said duties on bricks and tiles to be paid by the maker or makers thereof respectively.

the 3rd William IV. c. 11 (1833), the duties on * were wholly repealed, and two years afterwards duty on bricks was again raised, making the duty ommon bricks 5*s.* 10*d.* per thousand.

e brick duties formed the subject of the 18th ort of the Commissioners of Excise Enquiry, 1836; in 1839 these duties were repealed by the 2nd and Vict. c. 24, and a uniform duty of 5*s.* 10*d.* per thou-

By a curious oversight, this Act, which was intended to put *roofing* n the same footing as slates, also repealed the duties on *paving* tiles, t *bricks* used for paving remained subject to duty as before. Thus ap of clay put into a mould of 10 in. × 5 in. × 3 paid duty, but the quantity of clay put into a mould 10 in. square was duty free, because e under the denomination of a tile. The manufacturer, and not ublic, reaped the advantage thus given

sand imposed on all bricks of which the cubic cont did not exceed 150 cubic inches, without any distin tion as to shape or quality.

VIII. The new Act was a great boon to the pub as well as to the trade, as, in consequence of the remo of the restrictions on shape, bricks might be made any required pattern; and moulded bricks for cornic plinths, string-courses, &c., could be manufactured a moderate price. Under the old regulations, also, t brickmaker was precluded from correcting any defe which might arise from warping or twisting in t process of drying, without making himself liable to p the higher rate of duty. In 1850 the duty on bric was entirely repealed.

IX. The number of bricks annually made in Gre Britain is very great; just before the duty was repeale a charge was made on about 1,800,000,000 brick annually. In 1854 the number manufactured wa estimated to be over 2,000,000,000, of which abou 130,000,000 were made in the brickfields in an around Manchester, and about a similar number b the London brickmakers. The weight of this annu produce is upwards of 5,400,000 tons, representin a capital employed probably exceeding £2,000,000 Comparatively few bricks are made in Scotland, o account of the abundance of stone in that countr Those who are not practically connected with engineer ing works may find some difficulty in forming a clea conception of the immense number of bricks annuall made for railway purposes; and which may be roughl estimated at from 600 to 800 millions annually. I 1821, before the introduction of the railway system the number of bricks charged with duty in England and Scotland amounted to 913,231,000. In 1831 the

ıber was 1,153,048,581. In 1840 the number rose ,725,628,333.

. common turnpike road bridge over a railway ıires for its construction, in round numbers, 300,000 ks; and the lining of a railway tunnel of ordinary ensions consumes about 8,000 for every yard in ;th, or in round numbers about 14,000,000 per e.

. The processes employed in the manufacture of ks differ very greatly in various parts of the country. some districts the clay is ground between rollers, the pugmill is never used. In others, both rollers pugmills are employed. In the neighbourhood of ıdon the clay is commonly passed through a wash- . Equal differences exist in the processes of mould- and drying. Lastly, the form of the kiln varies atly. In many places the common Dutch kiln is one employed. In Essex and Suffolk the kilns have ıed furnaces beneath their floors; in Staffordshire ks are fired in circular domed ovens called cupolas; lst near London kilns are not used, and bricks are nt in clamps, the fuel required for their vitrifica- being mixed up with the clay in the process of pering.

I. Bricks vary very much in their strength, a point hich, although of considerable importance, very little ntion is paid. There is a striking difference in this pect between modern and ancient bricks; a differ- e very much in favour of those made centuries ago; , perhaps, the weakest bricks made are supplied by ıdon makers. In some experiments by Mr. Hawkes letailed account of which is given in the *Builder* 1861) it was found that of thirty-five kinds of bricks ch were tested, the average strength of the strongest

was 2,855 lbs.; of those of medium tenacity, 2,125 lbs. and of those of least strength, 1557 lbs. These brick were of the ordinary form, and varied in thickness from 3·25 to 1·7 inches. It was also found that the thinne kinds of bricks were proportionally stronger than those which were thicker; the greatest, mean, and leas strengths of the former being respectively 4,088 lbs. 2,954 lbs., and 2,070 lbs.

In comparing weight with strength, it was found that the average weight of twenty-five bricks from different districts, was 7·85 lbs., and that the heavies bricks were usually the strongest. The results of the following experiments are calculated according to a uniform standard:—Tipton blue bricks, weighing 10 lbs. gave 5,555 lbs., 3,975 lbs., and 2,801 lbs., as the greatest, mean, and least degree of strength. Boston bricks, weighing 9·88 lbs., gave 4,133 lbs., 3,198 lbs. and 2,616 lbs., as the value of the same items. Roman hypocaust tiles from the ancient city of Uriconium near Wroxeter, gave 4,670 lbs., 3,567 lbs., and 2,630 lbs. The Leeds bricks, weighing 9·17 lbs. gave 4,133 lbs., 3,198 lbs., and 2,616 lbs. Dutch clinkers, with a weight of only 6·56 lbs., gave the respective strength of 4,006 lbs., 3,345 lbs., and 2,542 lbs This is an exception to the general result of the heavies bricks being the strongest. Lastly, the lightest London bricks, weighing 6·19 lbs., gave 1,496 lbs., 998 lbs., and 366 lbs. The experiments also gave evidence of the fact that bricks were unable to sustain for any length of time a weight considerably less than that which was originally required to break them; for example, a Baltimore brick, which required 850 lbs. to break it, carried a weight of 735 lbs. for ten hours only, and then broke. It must be borne in mind that the second

ult is represented in terms of the whole brick, for sake of rendering the comparison more easy, hough, of course, the experiment could only be made the half brick.

XII. Now that machine-made bricks are getting o general use, notwithstanding that some opposition been made to their introduction, the following le may be interesting. It is a report of the results some experiments on hand-made and machine-made cks, with Messrs. Burton and Co.'s hydraulic press. the bricks were bedded upon a thickness of felt, l laid upon an iron-faced plate.

	Pressure to crack.	Pressure to crush.
	tons.	tons.
Good London grey stocks . . .	12·00 . . .	14·00
Best paviours to be got . . .	14·00 . . .	23·00
Red bricks, not fully burnt . . .	13·75 . . .	25 05
Ditto, ordinary quality	13·00 . . .	26·25
Three white bricks made by Clayton and Co.'s machinery .	17·05 . . .	41·05
Ditto, second best, with four bricks	16·25 . . .	41·00

In the following pages we have described at considerable length the practice of brickmaking as carried in Nottinghamshire, Staffordshire, Suffolk, and in e neighbourhood of London; and although the practice of almost every county presents some local peculiarity, the reader who has carefully gone through these counts will be enabled to understand the object of y processes not here described, and to form a tolerly correct judgment as to whether the process of anufacture in any district is conducted in a judicious anner; or whether the brickmaker has merely folwed the practices handed down by his predecessors thout any consideration as to the possibility of improving upon them. Before, however, entering upon e practical details of the subject, it is necessary that

the reader should have some knowledge of the genera principles of brickmaking, and of the nature of th processes employed; and these we shall proceed t consider in the following chapter.

CHAPTER I.

GENERAL PRINCIPLES OF THE MANUFACTURE OF BRICKS AND TILES.

1. BRICKS.

1. The whole of the operations of the brickmake may be classed under five heads, viz.:—

Preparation of brick earth.
Tempering.
Moulding.
Drying.
Burning.

We propose in this chapter to describe these opera tions one by one, pointing out the object to be effecte by each, and comparing at the same time the differen processes employed in various parts of this country fo the same end.

PREPARATION OF BRICK EARTH.

2. The qualities to be aimed at in making bricks fo building purposes may be thus enumerated:—Sound ness, that is, freedom from cracks and flaws; hardnes to enable them to withstand pressure and cross strain regularity of shape, that the mortar by which they ar united may be of uniform thickness to insure unifor mity of settlement; uniformity of size, that all th bricks in a course may be of the same height; un

rmity of colour, which is of importance only in namental work; facility of cutting, to enable the icklayer to cut them to any given shape, as required executing all kinds of gauged work; lastly, for rnace-work, and all situations exposed to intense at, infusibility.

3. Success in attaining the desired end depends iefly on a proper selection of brick earths; their dicious preparation before commencing the actual ocess of brickmaking, as well as on the drying and rning of the bricks. The other operations are atters of minor importance. Brickmaking may be ewed in two lights—as a science, and as an art. The rmer has been little studied, and is imperfectly underood; whilst the latter has been brought to great rfection.

4. The argillaceous earths suitable for brickmaking ay be divided into three principal classes, viz.:—

Pure clays, composed chiefly of alumina and silica, it containing a small proportion of other substances— iron, lime, magnesia, &c.*

* The following analyses of various kinds of clay are given in the cond volume of the English translation of "Knapp's Technological emistry."

	Cornish washed Kaolin.	Stourbridge fire clay.	Pipe clay.	Sandy clay.	Blue clay.	Brick clay.
ilica .	46·32	64·10	53·66	66·68	46·38	49·44
lumina	39·74	23·15	32·00	26·08	38·04	34·26
xide of iron	0·27	1·85	1·35	1·26	1·04	7·74
ime .	0·36	——	0·40	0·84	1·20	1·48
lagnesia	0·44	0·95	trace	trace	trace	5·14
otash & soda	12·67	——	——	——	——	——
Vater .		10·00	12·08	5·14	13·57	1·94
	99·80	100·05	99·49	100·00	100·23	100·00

Marls, which may be described as earths containing a considerable proportion of lime.

Loams, which may be described as light sandy clays.

It very seldom happens that earths are found which are suited for the purpose of brickmaking without some admixture. The pure clays require the addition of sand, loam, or some milder earth; whilst the loams are often so loose that they could not be made into bricks without the addition of lime to flux and bind the earth. Even when the clay requires no mixture, the difference in the working of two adjacent strata in the same field is often so great that it is advisable to mix two or three sorts together to produce uniformity in the size and colour of the bricks.

5. It appears, then, that a chemical compound of silica and alumina is the principal ingredient in all brick earth.* This silicate of alumina, or pure clay alone, or those clays which contain but little sand, may when beaten up with water into a stiff paste, be moulded with great ease into any shape; but will shrink and crack in drying, however carefully and slowly the operation be conducted; and will not stand firing, as a red heat causes the mass to rend and warp, although it becomes very hard by the action of the fire.

The addition of any substance which will neither combine with water, nor is subject to contraction, greatly remedies these defects, whilst the plastic quality of the clay is not materially affected. For this reason the strong clays are mixed with milder earth or with sand. The loams and marls used for brickmaking in the neighbourhood of London are mixed with lime and sifted breeze for the same purpose, and also to effect the fluxing of the earth, as will be presently described.

* Some remarks on the plasticity of clay will be found in the Appendix.

6. *Fire clays* or *refractory clays* are compounds of
ica, alumina, and water, or hydrated silicates of alu-
na represented by the formula $Al_2O_3, 2SiO_3 + 2HO$.
ich clays owe their refractory qualities to their com-
rative freedom from lime, magnesia, metallic oxides,
d similar substances which act as fluxes. Few
iys, however, exist in nature according to this pure
pe. The composition and quality of clays in con-
uous beds in the same pit, and even of clay from the
ne contiguous horizontal bed, may vary. "If we
mpare different clays together in respect to elementary
mposition, we find the relation between the silica and
imina to be extremely variable, and accordingly, the
rmulæ which have been proposed to express their
ional constitution are very discordant. This is in
eat measure to be explained by the fact, that in many
ys a large proportion of silica exists uncombined
her as sand, or in a much finer state of division.
e grittiness of a clay is due to the presence of sand."*
re-bricks are used in those parts of furnaces where
heat would soon destroy ordinary bricks. They are
de of various shapes and sizes as required, and are
en produced, as in the iron works of South Wales,
the spot. The clay is ground between rolls, or under
ge stones, and kneaded by treading. The bricks are
de by hand in moulds; they are carefully dried in
ves, and burnt at a high temperature in closed kilns.
rnt clay in powder is sometimes mixed with the raw
y. Stourbridge clay is celebrated for the manufacture
fine bricks, but clay from the coal-measures is also
gely used. All these bricks have a pale brownish
our, but they are sometimes mottled with dark spots,

* "Metallurgy," by John Percy, M.D., F.R.S., Lecturer on Metallurgy
e Government School of Mines. London, 1861.

which Dr. Percy refers to the presence of particles of iron pyrites. The *Dinas fire-brick* consists almost entirely of silica, the material being obtained from the rock of that name in the Vale of Neath. It lies on the limestone, and occasionally intermixes with it, and contains probably about 5 per cent. of calcareous matter. The bricks have extraordinary fire-proof qualities. The material had long been used as a sand, and many attempts were made to form it into bricks, without success, until a method was contrived by the late Mr. W. W. Young, when in 1822 a company was formed for the manufacture of these bricks. The mode of making the Dinas brick was long kept secret, but a number of original details concerning it are given in Dr. Percy's work. The material which is called *clay* is found at several places in the Vale of Neath in the state of rock, and disintegrated like sand. The colour when dry is pale grey. The rock is crushed to coarse powder between iron rolls; it softens by exposure to the air, but some of it is too hard to be used. "The powder of the rock is mixed with about 1 per cent. of lime and sufficient water to make it cohere slightly by pressure. This mixture is pressed into iron moulds, of which two are fixed under one press, side by side. The mould, which is open at the top and bottom, like ordinary brick-moulds, is closed below by a moveable iron plate, and above by another plate of iron, which fits in like a piston, and is connected with a lever. The machine being adjusted, the coarse mixture is put into the moulds by a workman, whose hands are protected by stout gloves, as the sharp edges of the fragments would otherwise wound them: the piston is then pressed down, after which the moveable bed of iron on which the brick is formed is lowered and taken away with the

ick upon it, as it is not sufficiently solid to admit of eing carried in the usual manner. The bricks are ied on these plates upon floors warmed by flues ssing underneath; and when dry they are piled in a rcular closed kiln covered with a dome, similar to lns in which common fire bricks are burned. About ven days of hard firing are required for these bricks, d about the same time for the cooling of the kiln. ne kiln contains 32,000 bricks, and consumes 40 ns of coal, half free-burning and half binding. The ice (1859) is 60*s.* the thousand."* The fracture one of these bricks shows irregular particles of quartz, d the lime which is added acts as a flux, causing them agglutinate. These bricks *expand* by heat, while icks made of fire clay *contract.* Hence they are seful for the roofs of reverberatory furnaces, and for rts where solid and compact lining is required. These liceous bricks must not be exposed to the action of ags rich in metallic oxides.

7. Fire clay, being an expensive article, is frequently ixed with burnt clay, often as much as two parts by eight to one of Stourbridge clay. Broken crucibles, d fire bricks, and old glass-pots ground to powder are so mixed with fire clay.

8. Fire clay is found throughout the coal measures, it that of Stourbridge is considered to be the best, as will bear the most intense heat that can be produced ithout becoming fused. Next in esteem to those of ourbridge are the Welsh fire bricks, but they will not ar such intense heat. Excellent fire bricks are made Newcastle and Glasgow. Fire bricks are made near indsor, at the village of Hedgerly, from a sandy

* In this year bricks were much cheaper than they have been since.

loam known by the name of Windsor loam, and much used in London for fire-work, and also by chemists for luting their furnaces, and for similar purposes.

The relative merits of Windsor, Welsh, Stourbridge, and other fire bricks, are best shown by their commercial value. The following items, extracted from the "Builders' and Contractors' Price Book for 1862," edited by G. R. Burnell, exhibit their relative cost:—

	Per 1000. £	s.	d.
Windsor fire bricks	5	4	0
Welsh ditto	5	4	0
Stourbridge ditto	7	0	0
Newcastle ditto	5	5	0
Alloa ditto	5	8	0
Dorset ditto	4	16	0

9. Bricks made of refractory clay, containing no lime or alkaline matter, are *baked* rather than burnt; and their soundness and hardness depend upon the fineness to which the clay has been ground, and the degree of firing to which it has been exposed.

10. It is very seldom that the common clays are found to be free from lime and other fluxes; and when these are present in certain proportions, the silica of the clay becomes fused at a moderate heat, and cements the mass together. Some earths are very fusible, and, when used for brickmaking, great care is requisite in firing the bricks to prevent them from running together in the kiln.

11. The earths used for brickmaking near London are not clays, but loams and marls. To render these earths fit for brickmaking, they are mixed with chalk ground to a pulp in a wash-mill. This effects a double purpose, for the lime not only imparts soundness to the bricks, acting mechanically to prevent the clay from shrinking and cracking, but also assists in fusing the

liceous particles; and when present in sufficient quan-
ty, corrects the evil effects of an overdose of sand, as
takes up the excess of silica that would otherwise
main in an uncombined state.

12. It will be seen from these remarks that we may
vide bricks generally into two classes—*baked* bricks
ade from the refractory clays, and *burnt* or vitrified
icks made from the fusible earths.

The fusible earths are the most difficult of treatment,
there is considerable practical difficulty in obtaining
sufficient degree of hardness without risking the
sion of the bricks; and it will be found that ordinary
ln-burnt bricks, made from the common clays, are for
e most part of inferior quality, being hard only on the
tside, whilst the middle is imperfectly burnt, and
mains tender. The superior quality of the London
alm bricks, which are made from a very fusible com-
und, is chiefly due to the use of sifted breeze,* which
thoroughly incorporated with the brick earth in the
gmill, so that each brick becomes a kind of fire ball,
d contains in itself the fuel required for its vitrifica-
n. In building the clamps the bricks are stacked
se together, and not as in ordinary kiln-burning, in
ich openings are left between the bricks to allow of
distribution of the heat from the live holes. The
ect of these arrangements is to produce a steady uni-
m heat, which vitrifies the bricks without melting
em. Those bricks which are in contact with the live
es or flues melt into a greenish black slag.

13. *Cutters*, that is, bricks which will bear cutting
l rubbing to any required shape, are made from
dy loams, either natural or artificial. In many

Breeze is a casual mixture of cinders, small coal, and ashes, such as
llected by the dustmen.

districts cutters are not made, there being no suitable material for the purpose. Bricks made from pure clays containing but little silica are hard and tough, and will not bear cutting.

14. We now come to the consideration of colour, which depends on the varying proportions of the hydrated oxide of iron in the clay, which change according to the amount of heat to which the bricks are subjected, and not on their natural colour before burning. This should be borne in mind, because brick-makers often speak of clays as red clay, white clay, &c., according to the colour of the bricks made from them, without any reference to their colour in the unburnt state.

If iron be present in clay without lime or simila substances, the colour produced at a moderate red hea will be red, the intensity of colour depending on th proportion of iron. The bind or shale of the coal mea sures burns to a bright clear red. If the clay b slightly fusible, an intense heat vitrifies the outside c the mass and changes its colour, as in the case of th Staffordshire bricks, which, when burnt in the ordinar way, are of a red colour, which, however, is changed t a greenish blue by longer firing at a greater heat. Th addition of lime changes the red produced by the oxid of iron to a cream brown, whilst magnesia brings it t a yellow. Few clays produce a clear red, the majori burning of different shades of colour, varying fro reddish brown to a dirty red, according to the propo tion of lime and similar substances which they contai Some clays, as the plastic clays of Suffolk, Devo shire,* and Dorsetshire, burn of a clear white, as m

* The plastic clay of Devonshire and Dorsetshire forms the basi the English stone ware. It is composed of about seventy-six parts

e seen in the Suffolk white bricks, which are much steemed for their soundness and colour. The London ıalms have a rich brimstone tint, which is greatly ssisted by the nature of the sand used in the process f moulding.

15. By employing metallic oxides and the ochreous etallic earths, ornamental bricks are made of a ıriety of colours. This, however, is a branch of brick-aking which has as yet received very little attention, though, with the rising taste for polychromatic deco-tion, it is well worthy of consideration.

Yellow clampt burnt bricks are made in the vicinity the metropolis, and in other* situations where milar material and fuel are readily obtained. *White* icks are made from the plastic clays of Devonshire d Dorsetshire, and also Cambridgeshire, Norfolk, ıffolk, and Essex, as well as in other counties. *Red* icks are made in almost every part of England; but e *fine red* or cutting brick is not generally made. *ue* bricks are made in Staffordshire, and are much ed in that part of England.

Sound and well-burnt bricks are generally of a clear d uniform colour, and when struck together will ring th a metallic sound. Deficiency in either of these ints indicates inferiority.

16. Bricks sufficiently light to float in the water were own to the ancients. This invention, however, was mpletely lost until rediscovered at the close of the

ca and twenty-four of alumina, with some other ingredients in very all proportions. This clay is very refractory in high heats, a property ch, joined to its whiteness when burned, renders it peculiarly valuable pottery, &c.

* Yellow clampt burnt bricks are made at Margate, in Kent, from the ches of plastic clay lying in the hollows of the chalk. The older part Margate is built of red bricks said to have been brought from Canter-y.

last century by M. Fabbroni, who published an accoun of his experiments. M. Fabbroni succeeded in makin floating bricks of an infusible earth called fossil meal which is abundant in some parts of Italy. Brieks mad of this earth are only one-sixth of the weight of eommo elay bricks, on whieh aecount they would be of grea serviee in vaulting church roofs, and for similar pur-poses. Ehrenberg, the eminent German mieroscopist showed that this earth eonsists almost entirely of th frustules or silieeous skeletons of various kinds o minute water plants.

Having thus briefly sketched the leading principle whieh should be our guide in the seleetion of bric earth, we will now proceed to describe the several pro-cesses by which it is brought into a fit state for use.

17. *Unsoiling.*—The first operation is to remove th mould and top soil, whieh is wheeled away, and shoul be reserved for resoiling the exhausted workings whe they are again brought into cultivation. In Londo the vegetable mould is called the *encallow,* and th operation of removing it, *encallowing.*

18. *Clay-digging and Weathering.*—The brick eart is dug in the autumn, and wheeled to a level plaee pre-pared to receive it, when it is heaped up to the dept of several feet, and left through the winter months t be mellowed by the frosts, whieh break up and crumbl the lumps. At the eommeneement of the brickmakin season, whieh generally begins in April, the clay i turned over with shovels, and tempered either by spad labour or in the pugmill; sufficient water being adde to give plasticity to the mass.

19. During these operations any stones which ma be found must be earefully pieked out by hand, whic is a tedious and expensive operation, but one whic

annot be neglected with impunity, as the presence of a ebble in a brick generally causes it to crack in drying, ad makes it shaky and unsound when burnt. If the arths to be used are much mixed with gravel, the only emedy is to wash them in a trough filled with water, ad provided with a grating sufficiently close to prevent ven small stones from passing through, and by means f which the liquid pulp runs off into pits prepared to eceive it, where it remains until, by evaporation, it ecomes sufficiently firm to be used. This process is sed in making cutting bricks, which require to be of erfectly uniform texture throughout their whole sub-ance; but it is tedious and expensive.

In working the marls of the midland districts, much ouble is experienced from the veins of skerry or im-ure limestone with which these earths abound. If a nall piece of limestone, no bigger than a pea, is allowed remain in the clay, it will destroy any brick into hich it finds its way. The carbonic acid is driven off y the heat of the kiln, and forces a vent through the de of the brick, leaving a cavity through which water nds its way, and the first sharp frost to which such brick may be exposed generally suffices to destroy ie face.

20. *Grinding.*—To remedy this serious evil, cast-iron llers are now generally used throughout the midland stricts for grinding the clay and crushing the pieces limestone found in it, and their introduction has een attended with very beneficial results. The clays the coal measures contain much ironstone, which quires to be crushed in the same manner.

In many yards the grinding of the clay is made to rm part of the process of tempering, the routine being follows:—clay-getting, weathering, turning over and

wheeling to mill, grinding, tempering, and moulding In Staffordshire the clay is not only ground, but is als pugged in the process of tempering, as described i chap. iv. art. 38; the routine is then as follows:— clay-getting, grinding, weathering, turning over, pug ging, moulding.

At a well-mounted brickwork in Nottingham, belong ing to Moses Wood, Esq., the clay used in making th best facing bricks is treated as follows:—it is firs turned over and weathered by exposure to frost; it i then again turned over, and the stones picked out b hand, after which it is ground between rollers set ver close together, and then left in cellars to ripen for year or more, before it is finally tempered for the us of the moulder. The bricks made from clay thu prepared are of first-rate quality, but the expense the process is too great to allow of much profit to tl manufacturer.

21. *Washing*.—The preparation of brick-earth in th neighbourhood of London is effected by processes qui different from those just described. For marl or *mal* bricks, the earth is ground to a pulp in a wash-mill, an mixed with chalk previously ground to the consisten of cream; this pulp, or, as it is technically calle malm, is run off through a fine grating into pits pr pared to receive it, and there left, until by evaporati and settlement, it becomes of sufficient consistency allow a man to walk upon it. It is then *soiled*, i covered with siftings from domestic ashes, and l through the winter to mellow. At the commenceme of the brickmaking season the whole is turned ov and the ashes thoroughly incorporated with the ea in the pugmill. In making common bricks, the wh of the earth is not washed, but the unwashed clay

aped up on a prepared floor, and a proportion of uid malm poured over it, after which it is soiled in e same way as for making malms.

These processes are well calculated to produce sound, rd, and well-shaped bricks. The washing of the clay ectually frees it from stones and hard lumps, whilst e mixing of the chalk and clay in a fluid state ensures e perfect homogeneousness of the mass, and enables e lime to combine with the silica of the clay, which uld not be the case unless it were in a state of nute division.

22. There are very few earths suitable in their natural te for making cutters. They are therefore usually de of washed earth mixed up with a proportion of d. Without the addition of sand the brick would bear rubbing, and it would be very difficult to bring o a smooth face.

23. It may be here observed that sufficient attention not generally paid to the preparation of brick-earth, t too frequently happens that the clay is dug in the ing instead of the autumn, in which case the benefit be derived from the winter frosts is quite lost. The of rollers, to a certain extent, counterbalances this; bricks made of clay that has been thoroughly thered are sounder and less liable to warp in the l.

TEMPERING.

4. The object of tempering is to bring the prepared k earth into a homogeneous paste, for the use of moulder.

he old-fashioned way of tempering was to turn the over repeatedly with shovels, and to tread it over orses or men, until it acquired the requisite plasti- This method is still practised in many country

yards; but where the demand for bricks is extensiv machinery is usually employed, the clay being eith *ground* between rollers or *pugged* in a pugmill. Th latter process is also called grinding, and, therefore, making inquiries respecting the practice of particul localities, the reader should be careful that he is n misled by the same name being applied to process which are essentially different.

When rollers are used in the preliminary process the labour of tempering is much reduced. Their use however, most generally confined to the process tempering, which is then effected as follows :—The cla which has been left in heaps through the winter mellow, is turned over with wooden shovels (wa being added as required), and wheeled to the m where it is crushed between the rollers, and falls on floor below them, where it is again turned over, and then ready for use.

When the clay is sufficiently mild and free from li and ironstone as not to require *crushing*, tempering spade labour and treading is generally adopted; in the districts where rollers are used, the brick-ear are generally so indurated that a great proportion co not be rendered fit for use by the ordinary process The advantages and disadvantages of the use of roll are considered at some length in chap. iii. art. 4.

25. In making bricks for railway works, which been done lately to an almost incredible extent, c tractors are generally little anxious as to the shape appearance of the article turned out of the kiln, p vided it be sufficiently sound to pass the scrutiny of inspector or resident engineer. As the whole proc of railway brickmaking often occupies but a few we from the first turning over of the clay to the laying

the bricks in the work, the use of rollers in such cases is very desirable, as a partial substitute for weathering. On the line of the Nottingham and Grantham Railway several millions of bricks have been made as follows:—The clay is first turned over with the spade, and watered and trodden by men or boys, who, at the same time, pick out the stones. It is then wheeled to the mill and ground; after which it is turned over a second time, and then passed at once to the moulding table.

26. Although in many country places, where the demand for bricks is very small, tempering is still performed by treading and spade labour, the pugmill is very extensively used near London, and in most places where the brick-earth is of mild quality, so as not to require crushing, and the demand for bricks sufficiently constant to make it worth while to erect machinery. The pugmill used near London is a wooden tub, in shape an inverted frustrum of a cone, with an upright revolving shaft passing through its centre, to which are keyed a number of knives, which, by their motion, cut and knead the clay, and force it gradually through the mill, whence it issues in a thoroughly tempered state, fit for the use of the moulder. Some contend that the pugmill is no improvement on the old system of tempering by manual labour; but, without entering into this question, there can be no doubt that it does its work very thoroughly, and its use prevents the chance of the tempering being imperfectly performed through the negligence of the temperers. In the London brickfields the process of tempering is conducted as follows:—The malm, or malmed brick-earth, as the case may be, is turned over with the spade, and the soil* (ashes) dug

* Soil, *i.e. ashes*, must not be confounded with soil, *vegetable mould*, which is in some places mixed with strong clay, to render it milder.

into it, water being added as may be necessary. It is then barrowed to the pugmill, and being thrown in at the top, passes through the mill, and keeps continually issuing at a hole in the bottom. As the clay issues from the ejectment hole, it is cut into parallelopipedons by a labourer, and, if not wanted for immediate use, is piled up and covered with sacks to prevent it from becoming too dry.

In Staffordshire steam power is used for driving both rollers and pugmill, and the case of the latter is usually a hollow cast-iron cylinder.

MOULDING.

27. A brick-mould is a kind of box without top o bottom, and the process of moulding consists in dashin the tempered clay into the mould with sufficient forc to make the clot completely fill it, after which th superfluous clay is *stricken* with a strike, and the newly made brick is either turned out on a drying floor t harden, or on a board or pallet, on which it is wheele to the hack-ground. The first mode of working known as *slop moulding*, because the mould is dippe in water, from time to time, to prevent the clay fro adhering to it. The second method may be distinguishe as *pallet moulding*; and in this process the mould not wetted, but sanded. These distinctions, howeve do not universally hold good, because in some plac slop-moulded bricks are turned out on pallets.

28. These differences may, at first sight, appe trivial, but they affect the whole economy of a bric work. In slop moulding the raw bricks are shifted hand from the moulding table to the drying floor, fro the drying floor to the hovel or drying shed, and fro

he hovel to the kiln. It is therefore requisite that he works should be laid out so as to make the distance o which the bricks have to be carried the shortest posible. Accordingly,* the kiln is placed in a central ituation in a rectangular space, bounded on two or nore sides by the hovel, and the working floors are ormed round the outside of the latter.

In the process of slop moulding the newly-made brick s carried, mould and all, by the moulder's boy to the lat, or drying floor, on which it is carefully deposited; nd whilst this is being done, the moulder makes a econd brick in a second mould, the boy returning with he first mould by the time the second brick is being inished. As soon, therefore, as the floor becomes illed for a certain distance from the moulding table, the atter must be removed to a vacant spot, or the distance o which the bricks must be carried would be too great o allow of the boy's returning in time with the empty nould.

29. In pallet moulding but one mould is used. Each rick, as it is moulded, is turned out on a pallet, and laced by a boy on a hack-barrow, which, when loaded, s wheeled away to the hack-ground, where the bricks re built up to dry in low walls called hacks. One noulder will keep two wheelers constantly employed, wo barrows being always in work, whilst a third is eing loaded at the moulding stool. When placed on he barrow, it is of little consequence (comparatively) whether the bricks have to be wheeled 5 yards or 50; nd the distance from the moulding stool to the end of he hacks is sometimes considerable.

30. The moulding table is simply a rough table, made

* There are, of course, some exceptions; but, where practicable, the rying floors and hovel are placed close to the kilns.

in various ways in different parts of the country, but the essential differences are, that for slop moulding the table is furnished with a water trough, in which the moulds are dipped after each time of using; whilst in pallet moulding, for which the mould is usually sanded and not wetted, the water trough is omitted, and a *page* (see account of Brickmaking as practised in London) is added, on which the bricks are placed preparatory to their being shifted to the hack-barrow.

31. Brick moulds are made in a variety of ways. Some are made of brass cast in four pieces and riveted together; some are of sheet iron, cased with wood on the two longest sides; and others again are made entirely of wood, and the edges only plated with iron. Drawings and detailed descriptions of each of these constructions are given in the subsequent chapters. In using wooden moulds the slop-moulding process is almost necessary, as the brick would not leave the sides of the mould unless it were very wet. Iron moulds are sanded, but not wetted. Brass, or, as they are technically called, copper moulds, require neither sanding nor wetting, do not rust, and are a great improvement on the common wooden mould formerly in general use. They, however, are expensive, and will not last long, as the edges become worn down so fast that the bricks made from the same mould at the beginning and end of a season are of a different thickness, and cannot be used together. This is a great defect, and a metal mould which will not rust nor wear is still a great desideratum. It is essential that the sides of the mould should be sufficiently stiff not to *spring* when the clay is dashed into it, and it is equally requisite that it should not be made too heavy, or the taking-off boy would not be able to carry it to the floor. A common

opper mould weighs about 4 lbs., and, with the wet riek in it, about 12 lbs., and this weight should not e exeeeded.

32. There is a great difference in the quantity of rieks turned out in a given time by the pallet moulding nd by the slop moulding processes. In slop moulding 0,000 per week is a high average, whilst a London ioulder will turn out 36,000 and upwards in the same eriod. This arises in a great measure from the cir-umstance that in pallet moulding the moulder is ssisted by a elot moulder, who prepares the clot for ashing into the mould; whilst in slop moulding the hole operation is eonducted by the moulder alone.

33. In some places the operation of moulding par-kes both of slop moulding and pallet moulding, the ricks being turned out on pallets and barrowed to the ack-ground, whilst the moulds are wetted as in the rdinary proeess of slop moulding.

34. The substitution of machinery for manual labour the proecss of moulding has long been a favourite ibjeet for the exereise of meehanical talent; but though a great number of inventions have been pa-nted, there are very few of them that ean be said to thoroughly sueeessful. The aetual eost of moulding ars so small a proportion to the total eost of briek-aking, that in small briekworks the employment of aehinery would effect no ultimate saving, and, there-re, it is not to be expeeted that maehinery will ever generally introdueed for briek moulding. But in orks situated near large towns, or in the exeeution of rge engineering works, the ease is very different, and contractor who requires, say, 10,000,000 of bricks, to made in a limited time, for the construetion of a nnel or a viaduct, ean cmploy machinery with great

advantage. A chapter on brickmaking machines wil be found in another part of this volume.

35. It has been much discussed by practical men whether bricks moulded under great pressure are bette than those moulded in the ordinary way. They are o denser texture, harder, smoother, heavier, and stronge than common bricks. On the other hand, it is difficul to dry them, because the surfaces become over-drie and scale off before the evaporation from the centre i completed. Their smoothness lessens their adhesion t mortar; and their weight increases the cost of carriag and renders it impossible for a bricklayer to lay a many in a given time as those of the ordinary weigh On the whole, therefore, increased density may be con sidered as a disadvantage, although, for some purpose dense bricks are very valuable.

36. Mr. Prosser, of Birmingham, has introduced method of making bricks, tiles, and other articles b machinery, in which no drying is requisite, the cla being used in the state of a nearly dry powder. Th clay from which floor-tiles and tesseræ are made is firs dried upon a slip-kiln,* as if for making pottery, the ground to a fine powder, and in that state subjected t heavy pressure† in strong metal moulds: by this mean the clay is reduced to one-third of its original thicknes and retains sufficient moisture to give it cohesion. Th articles thus made can be handled at once, and carrie direct to the kiln. In some experiments tried for asce taining the resistance of bricks and tiles thus made t

* The *slip-kiln* is a stone trough bottomed with fire tiles, under whic runs a furnace flue. It is used in the manufacture of pottery for evap rating the excess of water in the *slip*, or liquid mixture of clay and grou flints, which is thus brought into the state of paste.

† It is a common but an erroneous notion, that articles made by M Prosser's process are denser than similar articles made in the comm way: the reverse is the fact.

crushing force, a 9-inch brick sustained a pressure of
) tons without injury.

37. Mr. Prosser's method offers great advantages for e making of ornamental bricks for cornices, bas-liefs, floor-tiles, tesselated pavements, &c. Screw esses are used to a considerable extent for pressing icks when partially dry, to improve their shape and give them a smooth face; but we have in many in-ances found pressed bricks to *scale* on exposure to ost, and much prefer dressing the raw brick with a ater, as described in chap. iii. art. 34.

38. The great practical difficulty in making moulded cks for ornamental work is the warping and twisting which all clay ware is subject more or less in the ocess of burning. This difficulty is especially felt in king large articles, as wall copings, &c. In moulding ods of this kind it is usual to make perforations ough the mass, to admit air to the inside, without ich precaution it would be impossible to dry them roughly; for, although the outside would become d, the inside would remain moist, and, on being jected to the heat of the kiln, the steam would crack burst the whole.

The Brighton Viaduct, on the Lewes and Hastings lway, has a massive white brick * dentil cornice, the cks for which were made in Suffolk after several uccessful attempts to make bricks of still larger size. thickness of the bricks first proposed presenting an rmountable obstacle to their being properly dried, r dimensions were reduced, and large perforations e made in each brick to reduce its weight, and to ble it to be more thoroughly and uniformly dried;

Brick was preferred to stone on account of the expense of the latter rial.

and by adopting this plan the design was successfull carried into execution.

39. The usual form of a brick is a parallelopipedon about 9 in. long, $4\frac{1}{2}$ in. broad, and 3 in. thick, the exac size varying with the contraction of the clay. Th thickness need not bear any definite proportion to th length and breadth, but these last dimensions requir nice adjustment, as the length should exceed twice th breadth by the thickness of a mortar joint.

40. Bricks are made of a variety of shapes for pa ticular purposes, as enumerated in art. 60, chap. iii. Th manufacture of these articles is principally carried on the country, the brickfields in the vicinity of the metr polis supplying nothing but the common building bric

41. A point of some little importance may be he adverted, to, viz., is any advantage gained by forming hollow in the bed of the brick to form a key for t mortar? There are various opinions on this point; b we think it may be laid down as a principle, that if it useful on one side it will be still better on both, so as form a double key for the mortar. In London, t brick mould is placed on a stock board, which is ma to fit the bottom of the mould; and the relative positio of the two being kept the same, no difficulty exists forming a hollow on the bottom of the brick, this bei effected by a *kick* fastened on the stock board. B this could not be done on the *upper* side, which stricken level. In slop moulding, the mould is sim laid on the moulding stool, or on a moulding boa much larger than the mould, and both sides of the bri are flush with the edges of the mould, no hollow bei left, unless the moulder think fit to make one by scori the brick with his fingers, which is sometimes do When machinery is used in moulding, it is equally e

o stamp the top and the bottom of the brick; and we ave seen, at the Butterly Ironworks, in Derbyshire, xcellent machine-made bricks of this kind made in ie neighbourhood.

42. Amongst the many inventions connected with rickmaking which have been from time to time brought efore the public, *ventilating* bricks deserve attention, om the facilities they afford for warming and venti- ting buildings.

The annexed figures show the form of the bricks and ie way in which they are used.

Fig. 1.

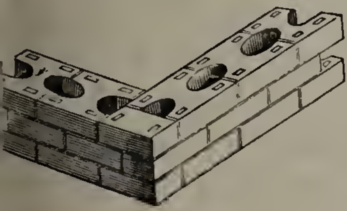


Fig. 2.

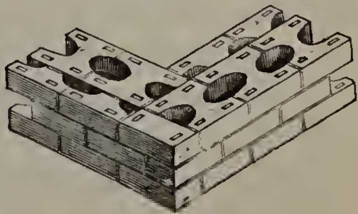


Fig. 3.

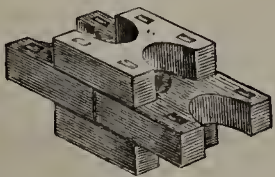


Fig. 1 is a representation of a 9-in. wall, built with e ventilating bricks, with one common brick used at e angle of each course.

Fig. 2 is a representation of a 14-in. wall; the half ntilating brick, being used alternately in the courses, ms a perfect and effectual bond.

Fig. 3 is an isometrical drawing showing the venti- ing spaces.

DRYING.

43. The operation of drying the green bricks requires at care and attention, as much depends upon the

manner in which they are got into the kiln. The great point to be aimed at is to protect them against sun, wind, rain, and frost, and to allow each brick to dry uniformly from the face to the heart.

Slop-moulded bricks are usually dried on flats or drying floors, where they remain from one day to five or six, according to the state of the weather. When spread out on the floor they are sprinkled with sand, whicl absorbs superfluous moisture, and renders them les liable to be cracked by the sun's rays. After remainin on the floors until sufficiently hard to handle withou injury, they are built up into hacks under cover, wher they remain from one to three weeks, until ready for th kiln. In wet weather they are spread out on the floo of the drying shed, and great care must then be take to avoid drafts, which would cause the bricks to dr faster on one side than the other. To prevent thi boards set edgeways are placed all round the shed t check the currents of air.

The quantity of ground required for drying bricks i this manner is comparatively small, as they remain c the floors but a short time, and occupy little space whe hacked in the hovels. The produce of a single mouldir stool by the slop-moulding process seldom exceed 10,000 per week, and the area occupied by each stool i therefore, small in proportion. Half an acre for eac kiln may be considered ample allowance for the workir floor and hovel.

44. In places where brickmaking is conducted on large scale, drying sheds are dispensed with, and t hacks are usually built in the open air, and protect from wet, frost, and excessive heat, by straw, reed matting, canvas screens, or tarpaulins; all of which have seen used in different places.

45. Bricks intended to be clamp burnt are not dried on flats, but are hacked at once on leaving the moulding stool, and remain in the hacks much longer than bricks ntended to be kilned. This is rendered necessary by he difference between clamping and kilning. In the atter mode of burning, the heat can be regulated to great nicety, and if the green bricks, when first placed n the kiln, be not thoroughly dried, a gentle heat is pplied until this is effected. In clamping, however, he full heat is attained almost immediately, and, herefore, the bricks must be thoroughly dried, or they vould fly to pieces. In the neighbourhood of London good moulder, with his assistants, will turn out from 0,000 to 40,000 bricks per week, and the clamps ontain from 60,000 to 120,000 bricks and upwards.

From these combined causes, the area occupied by ach stool is greater than in making slop-moulded ricks. In Mr. Bennett's brick-ground at Cowley, ten tools occupy twenty acres.

46. At the risk of wearying the patience of the eader, we recapitulate the leading points on which epends the difference of area required for each mould- g stool in making:—

lop-moulded bricks, hacked under cover, and burnt in kilns.		London pallet-moulded sand stocks, burnt in clamps.
ried one day on flats . . .	1st	Hacked at once.
losely stacked in hacks 17 courses high, placed close together under cover . . .	2nd	Bricks loosely stacked in hacks, 8 courses high and 2 bricks wide, with 9 ft. spaces between the hacks.
emain in shed 10 to 16 days	3rd	Remain in hacks 3 to 6 weeks.
ate of production per stool, about 10,000 weekly . . .	4th	A gang will turn out 30,000 to 40,000 per week.
iln holds about 30,000 bricks, and may be fired once in 10 days	5th	Clamp contains 60,000 to 120,000 bricks, and burns from 2 to 6 weeks.

47. It is scarcely necessary to observe that different

clays require different treatment, according to their composition, some bricks bearing exposure to sun and rain without injury, whilst others require to be carefully covered up to keep them from cracking under similar circumstances. [See Appendix.]

Superior qualities of bricks are generally *dressed* with a beater when half dry, to correct any twisting or warping which may have taken place during the first stage of drying.

BURNING.

48. Bricks are burnt in *clamps* and in *kilns*. The latter is the common method, the former being only employed in burning bricks made with ashes or coal-dust. It should be observed, however, that the name of clamp is applied also to a pile of bricks arranged for burning in the ordinary way, and covered with a temporary casing of burnt brick to retain the heat; but this must not be confounded with close-clamping as practised in the neighbourhood of London.

49. The peculiarity of clamp burning is that each brick contains in itself the fuel necessary for its vitrification; the breeze or cinders serving only to ignite the lower tiers of bricks, from which the heat gradually spreads over the whole of the clamp. No spaces are left between the bricks, which are closely stacked, that the heat to which they are exposed may be as uniform as possible. It is unnecessary here to go into the details of clamping, as they are very fully given in the account of London Brickmaking. [See also Appendix.]

50. A *kiln* is a chamber in which the green bricks are loosely stacked, with spaces between them for the passage of the heat; and baked by fires placed either

n arched furnaces under the floor of the kiln, or in fire ioles formed in the side walls.

There are many ways of constructing kilns, and careely any two are exactly alike; but they may be livided into three classes :—

1st. The common rectangular kiln with fire-holes in he side walls. This is formed by building four walls nclosing a rectangular space, with a narrow doorway t each end, and narrow-arched openings in the side valls exactly opposite to each other. The bricks are ntroduced through the doorways, and loosely stacked vith considerable art, the courses being crossed in a urious manner, so as to leave continuous openings rom top to bottom of the pile to distribute the heat. n the lower part of the kiln narrow flues are left, about in. wide and about 2 ft. or 3 ft. high, connecting the re-holes in the side walls. The kilns having been lled, the doorways are bricked up and plastered with lay to prevent the ingress of cold air; the top of the iln is covered with old bricks, earth, or boards, to etain the heat, and the firing is carried on by burning oal in the fire-holes. A low shed is generally erected n each side of the kiln to protect the fuel and fireman om the weather, and to prevent the wind from urging ie fires. The details of the management of a kiln are iven in another place, and need not be here repeated. his kind of kiln is he simplest that can well be lopted, and is in use in Holland at the present day. is the kiln in common use through the Midland stricts.

2nd. The rectangular kiln with arched furnaces. his consists also of a rectangular chamber; but differs om the first in having two arched furnaces running ider the floor the whole length of the kiln, the furnace

doors being at one end. The floor of the kiln is formed like lattice-work, with numerous openings from the furnaces below, through which the heat ascends. The top of the kiln is covered by a moveable wooden roof, to retain the heat, and to protect the burning bricks from wind and rain. These kilns are used in the east of England.

3rd. The circular kiln or cupola. This is domed over at the top, whence its name is derived. The fire-holes are merely openings left in the thickness of the wall, and are protected from the wind by a wall built round the kiln at a sufficient distance to allow the fireman room to tend the fires. These cupolas are used in Staffordshire and the neighbourhood, and the heat employed in them is very great. Drawings of a cupola are given in chap. iv., with an account of the manner in which the firing is conducted, and therefore it is unnecessary to enter here upon any of these details.

51. The usual method of placing bricks in the kiln is to cross them, leaving spaces for the passage of the heat, but there are objections to this, as many bricks show a different colour, where they have been most exposed to the heat. Thus in many parts of the country, the bricks exhibit a diagonal stripe of a lighter tint than the body of the brick, which shows the portion that has been most exposed. In burning bricks that require to be of even colour, this is guarded against by placing them exactly on each other.

On first lighting a kiln the heat is got up gently, that the moisture in the bricks may be gradually evaporated.

When the bricks are thoroughly dried, which is known by the steam ceasing to rise, the fires are made fiercer, and the top of the kiln is covered up with boards, turf, old bricks, or soil, to retain the heat. As

ıe heat increases, the mouths of the kiln are stopped) check the draft, and when the burning is completed, ıey are plastered over to exclude the air, and the fires ɾe allowed to go out. After this the kiln is, or should e, allowed to cool very gradually, as the soundness of ıe bricks is much injured by opening the kiln too ɔon.

Pit coal is the fuel commonly used, and the quantity equired is about half a ton per 1,000 bricks; but much epends on the quality of the coal, the construction of ıe kiln, and the skill with which the bricks are stacked.

Wood is sometimes used as fuel in the preliminary age of firing, but not to a great extent. In a letter eceived on the management of the Suffolk kilns, the riter says, "The usual mode of firing bricks in Suffolk in a kiln. The one near me, belonging to a friend of ıine, is constructed to hold 40,000; it is about 20 ft. ng and 15 ft. broad, and is built upon two arched ırnaces that run through with openings to admit the eat up. The bricks are placed in the usual way for ırning, by crossing so as to admit the heat equally ırough, when the whole mass becomes red hot: the st three or four days, wood is burnt in what is called ıe process of annealing; with this they do not keep up fierce fire. After this from 12 to 14 tons of coal are nsumed in finishing the burning. Private individuals metimes make and clamp 20,000 or 30,000 without a ln; then there is great waste, and the bricks are not well burnt.

52. In the preceding pages we have briefly sketched e operations of brickmaking, and the principles on hich they depend. In the following chapters the ader will find these operations described in detail, as actised in different parts of the country; it need

hardly be said that the illustrations might be greatly extended, as there are scarcely two counties in England in which the processes are exactly similar, but this would lead us far beyond the limits of a Rudimentary Treatise, and enough is given to show the student the interest of the subject, and to enable him to think and examine for himself. If he be induced to do this from the perusal of these pages, the aim of this little volume will have been completely fulfilled.

II. TILES.

53. The manufacture of tiles is very similar to that of bricks, the principal differences arising from the thin- ness of the ware, which requires the clay to be purer and stronger, and renders it necessary to conduct the whole of the processes more carefully than in making bricks.

54. Tiles are of three classes, viz., paving tiles, roof- ing tiles, and drain tiles.

Paving tiles may be considered simply as thin bricks and require no especial notice.

Roofing tiles are of two kinds: pantiles, which are o a curved shape, and plaintiles, which are flat, the latte being often made of ornamental shapes so as to forn elegant patterns when laid on a roof.

Pantiles are moulded flat, and afterwards bent int their required form on a mould. Plain tiles wer formerly made with holes in them for the reception c the tile-pins, by which they were hung on the laths but the common method is now to turn down a coupl of nibs at the head of the tile, which answer the sam purpose.

Besides pantiles and plaintiles, hip, ridge, an

lley tiles, come under the denomination of roofing es; these are moulded flat, and afterwards bent on a ould, as in making pantiles.

Draining tiles belong to the coarsest class of earthen-re. They are of various shapes, and are made in rious ways. Some are moulded flat, and afterwards nt round a wooden core to the proper shape. Others made at once of a curved form, by forcing the clay rough a mould by mechanical means. Tile-making chines are now almost universally superseding manual bour in this manufacture, and many machines of rious degrees of merit have been patented during the t few years.

55. Besides the above articles, the business of a tilery ludes the manufacture of tiles for malting floors, mney-pots, tubular drains, and other articles of tery requiring the lathe for their formation. We do , however, propose now to enter upon the potter's , which, indeed, would require an entire volume, but ll confine ourselves to the description of the manu-ture of roofing tiles as made in Staffordshire, and at London tileries, adding a few words on the making esseræ and ornamental tiles as practised by Messrs. nton, of Stoke-upon-Trent.

6. In the country it is common to burn bricks* and s together, and as, in most places, the demand for cks is not great, except in the immediate vicinity of ge towns, where the demand is more constant, the nufacturer generally only makes so many bricks as required to fill up the kiln.

Where there is a great and constant demand for cks and tiles, their manufacture is carried on sepa-

* In some places bricks and *lime* are burnt together.

rately, and tiles are burnt in a large conical build
called a dome, which encloses a kiln with arched
naces. There are many of these in the neighbourh
of London, and, as we have described them very full
the chapter on London Tileries, we need say noth
further here on this subject.

57. The manufacture of draining tiles is one wh
daily assumes greater importance on account of
attention bestowed on agriculture, and the grow
appreciation of the importance of thorough drain
Any discussion on the best forms of draining tiles
the most advantageous methods of using them, wo
however, be out of place in this volume. Neither
we say much on the practical details of the manufact
as it is exceedingly simple, and as regards the prep
tion of the clay, and the processes of drying and burn
is precisely similar to the other branches of tile-mak
With regard to the process of moulding, there is
doubt but that hand moulding will soon be ent
superseded by machinery; and the discussion of
merits of the numerous excellent tile-making mach
now offered to the public, although of great intere
those engaged in the manufacture, would be unsuit
the pages of a rudimentary work, even were it pr
cable to give the engravings which would be neces
to enable the reader to understand their compar
advantages or defects.* A few words on the prin
features of the manufacture of drain tiles are, how
required to enable the reader to appreciate its pec
character.

58. Bricks, paving tiles, and roofing tiles, are
required, and seldom manufactured, except in the n

* A few details will be found in the chapter on Brickmaki
Machinery.

rhood of towns or of large villages, where the demand likely to be sufficiently constant to warrant the ction of kilns, drying sheds, and other appurtenances a well-mounted brickwork. If a cottage is to be uilt, a barn tiled, or it may be once in twenty or rty years a new farmsteading erected in a rural dis-t, it is generally cheaper to incur the expense of ting a few thousand bricks or tiles than to erect the nt necessary for making these articles on the spot. But with drain tiles the case is reversed. They are st wanted precisely in situations where a brick-yard uld be an unprofitable speculation, viz., in the open ntry, and often in places where the cost of carriage m the nearest brick-yard would virtually amount to rohibition in their use, if they cannot be made on spot, and that at a cheap rate. What is wanted, refore, is a good and cheap method of making drain s without much plant, and without erecting an expen-e kiln, as the works will not be required after sufficient s have been made to supply the immediate neighbour-d, and therefore it would not be worth while to incur expense of permanent erections. The making drain s a *home manufacture* is, therefore, a subject which much engaged the attention of agriculturists during last few years, and it gives us great pleasure to enabled to give engravings of a very simple and ctive tile-kiln erected by Mr. Law Hodges, in his ck-yard, and described in the *Journal of the Royal ricultural Society*, vol. v., part 2, from which publi-ion we have extracted so much as relates to the cription of this kiln, and the cost of making drain s in the manner recommended by him. [See Ap-dix.]

59. We have already extended this sketch of the

general principles and practice of brick and tile maki
beyond its proper limits, and must therefore pass on
the practical illustrations of our subject.

The chapter "On the Manufacture of Bricks a
Tiles in Holland" is reprinted from the third volume
Weale's "Quarterly Papers on Engineering," and w
be read with interest on account of the great similar
of the English and Dutch processes.

The account of brickmaking, as practised at N
tingham and the Midland counties, was written fr
personal examination of brickworks in the vicinity
Nottingham, and in the counties of Derby, Leicest
and Lincoln, and has been carefully revised by a g
tleman long connected with one of the principal bri
works near Nottingham.

The paper "On Brickmaking, as practised in
Staffordshire Potteries," was contributed to this volu
by Mr. R. Prosser, of Birmingham, whose name i
sufficient guarantee for the value of the informat
therein contained. The details for this paper were
lected by Mr. Prosser's assistant, Mr. John Turley
Stoke; and the valuable analyses of brick-earths w
made for Mr. Prosser by Mr. F. C. Wrightson,
Birmingham, at a considerable expense.

The description of brickmaking in the vicinity
London has been drawn up with great care, and is
first illustrated account that has yet appeared of
manufacture of clamp bricks. The drawings acc
panying this paper, and that on the London Tile
are from the pencil of Mr. B. P. Stockman.

Professional engagements preventing a personal
mination of the processes employed in brick and t
making in the vicinity of the metropolis, Mr. Stock
kindly undertook this task, and to his perseve

ergy and talent we are indebted for a great mass of actical details embodied in these two chapters.

Lastly, in the Appendix are inserted various par- ulars relative to brickmaking which could not have en introduced in any other part of the volume with- t interrupting the continuity of the text.

It should be noted that the various prices and esti- ates given in the following pages, refer to the time at ich the descriptions were given. They are, of course, bject to later modifications.

CHAPTER II.

ON THE MANUFACTURE OF BRICKS AND TILES IN HOLLAND. By Hyde Clarke, C.E.

I.—BRICKS.

E Dutch make a most extensive use of bricks, of ich they have several kinds. Not only are bricks ed for ordinary building purposes, and for furnaces, t also in great quantities for foot pavements, towing- ths, streets, and high roads. It may be observed, at they have of late been used very effectively in this untry for the pavement of railway stations. The ing bricks, or Dutch clinkers, are the hardest sort, d are principally manufactured at Moor, a smal vil- e about two miles from Gouda, in South Holland. e brick-fields are on the banks of the river Yssel, m which the chief material is derived, being no other n the slime deposited by the river on its shores, and the bottom. The slime of the Haarlem Meer is also ensively used for this purpose, as most travellers ow. This is collected in boats, by men, with long

poles having a cutting circle of iron at the end, and
bag-net, with which they lug up the slime. The san
is also obtained by boatmen from the banks of the riv
Macs. It is of a fine texture, and grayish colour. Th
hard bricks are made with a mixture of this slime an
sand, but in what proportions I am not informe
River sand is recognised as one of the best materia
for bricks, and is used by the London brickmakers, wh
obtain it from the bottom of the Thames, near Woo
wich, where it is raised into boats used for the purpos
For what are called in France, Flemish bricks, an
which are manufactured in France, Flanders, and
the corresponding Belgian frontier, river sand is pr
ferred, and is obliged to be obtained from the Schel
At Ghent, and lower down, a considerable traffic
carried on in the supply of this material. The quanti
used there is about one cubic foot of sand per cub
yard.

The slime and sand, being mixed, are well knead
together with the feet, and particular attention is pa
to this part of the process. The mixture is then dep
sited in heaps. The mode of moulding and drying
similar to that used elsewhere. Paving bricks a
generally about 6 in. long, 4 in. broad, and $1\frac{3}{4}$ in. thic
Dutch clinks made in England are 6 in. long, 3
broad, and 1 in. thick.

The house bricks and the tiles are made for the mo
part at Utrecht, in the province of the same name, fro
brick earth found in the neighbourhood. House bric
are about $9\frac{1}{2}$ in. long, $4\frac{1}{2}$ in. wide, and nearly 2 in. thic

II.—BRICK-KILNS.

The kilns are built of different sizes, but genera
on the same plan. Sometimes they will take as ma

1,200,000 bricks. A kiln for burning 400,000 bricks once is represented in the "Memoirs of the Academy Sciences of France." It is a square of about 33 ft. or ft. long by 28 ft. or 30 ft. wide, closed in with four alls of brick, 6 ft. thick at the base, and which slope owards outside to their extreme height, which is about ft. Some slope also slightly inwards, but in a different direction. Different plans are nevertheless lopted with regard to the form of the external walls, e great object being, however, to concentrate the heat much as possible. In the walls, holes are left for flue-holes, and sometimes for eight or ten or twelve. one of the walls, in the breadth of the kiln, an ched doorway is made, about 6 ft. wide and 12 ft. gh, by which the bricks are brought into the kiln. ie arrangements as to the doorway are also subject to riation. The interior of the kiln is paved with the icks, so as to present a level base. The walls are laid th mortar of the same earth from which the bricks e made, and with which they are also plastered inle; yet, notwithstanding the strength with which they e built, the great power of the kiln fire sometimes icks them. The kilns, I would observe, are not usually vered in, but some of those for baking building-bricks ve roofs made of planks, and without tiles, to shelter em from the wind and rain. Others are provided h rush mats, which are changed according to the e on which the wind blows. The matting also serves protecting the bricks against the rain, whilst the n is being built up. A shed, or hangar, is put up on h side of the kiln, in order to contain the peat turf, to shelter the fire-tender, and to preserve the fires inst the effects of wind. Such being the practice h regard to roofing, when the bricks are put into the

kiln, a layer, or sometimes two layers, of burnt briel is placed on the floor, laid lengthwise, about thre quarters of an inch from each other, and so as to slo a little from the parallel of the walls, that they ma the better support the upper rows, which are alwa laid parallel to the walls. This layer is covered wi old rush mats, on which are arranged the dried brick which are laid without intervals between them. It said that the mats serve to prevent the humidity of t soil from penetrating to the bricks while the kiln being filled, which generally takes from about thr weeks to a month. This row of burnt bricks is placed as to leave channels or flues of communicati with corresponding openings in the kiln walls. S layers of dried bricks having been put down, the ne three rows are made to jut over, so as to shut up t channels or flues. The layers are thus carried up about forty-five in number, the last two being of bur bricks, though in some kilns four layers of burnt bric are used for closing in. The crevices are secured wi brick earth or clay, on which sand is put; the door the kiln is then closed with one or two thicknesses burnt brick, then an interval of about 10 in. or 12 i filled in with sand, and this secured with walling, a by a wooden strut. The object of the sand is to preve any of the heat from escaping through the crevices.

It is to be remarked that, in laying the bricks in t kiln, as they are laid down, a cloth is put over the and under the feet of the workmen, so as to prevent a of the sand which might fall off, from getting do and blocking up the interval or interstice which nat rally remains between each brick, and so interrupti the passage of the flame, and causing an unequal he or combustion in the kiln.

The kiln being filled, a sufficient quantity of peat t

introduced into the flues, of which one end is closed with burnt bricks, and the turf is set fire to. The rf used is from Friesland, which is reckoned better an Holland turf, being lighter, less compact, and less rthy, composed of thicker roots and plants, burning icker and with plenty of flame, and leaving no ash. ne general time in Holland during which the supply turf by the flues is kept up, is for about four-and-enty hours, taking care at first to obtain a gradual at, and supplying fresh turf about every two hours. ne fireman, by practice, throws the turfs in through e small fire openings, and as far in as he judges cessary. When one side has thus been heated, the e openings are closed, and the other ends opened for ır-and-twenty hours, and supplied with fuel; and this ernate process is kept up for about three or four eks, the time necessary to burn large bricks. In ne kilns, however, the fire is kept up for five or six eks, depending upon their size and the state of the ather. A fortnight or three weeks is, however, netimes enough for the clinkers.

The burning having been concluded, about three eks are allowed for cooling. It generally happens t the mass of brick sinks in in some places, arising tly from the diminution of volume produced by ning, and partly from the melting of some of the cks which have been exposed to too great heat.

The quality of the bricks depends upon the degree burning to which they have been subjected. Those n about a third from the middle of the top of the ı, or near the centre, are black, very sonorous, com-t and well shaped, breaking with a vitrified fracture. se are generally employed for cellars, reservoirs, cisterns, and are most esteemed.

III.—TILES.

The tiles manufactured in Holland are flat, hollow, shaped, or with a square opening in the middle to l in a pane of glass, being much used for lighting lof and garrets all over the Low Countries. They a either red, grey, or blue, or glazed on one side onl The flat paving tiles are about 8½ in. square by 1 i thick; they are used principally for cisterns and f bakers' ovens. The clay for tiles, it is to be noted, in all cases more carefully prepared than that for brick being ground up wet in a pugmill or tub, with a sha carrying half a dozen blades. By this means, root grass, &c., are got rid of. The clay comes out of t pugmill of the consistence of potters' clay, and is ke under a shed, where it is kneaded by women, with th hands, to the rough form of a tile, on a table dust with sand. These pieces are carried off to the moulde who are two in number, a rough moulder and a finish The tiles are then dried under sheds, and afterwards the sun. With regard to the flat paving tiles, they a at first rough-moulded about an inch larger than t subsequent size, and a little thicker, and then laid c to dry under a shed, until such time as the thumb c hardly make an impression on them. They are th taken to a finishing-moulder, who, on a table quite le and slightly dusted with sand, lays one of the tiles, a strikes it twice or thrice with a rammer of wood larg than the tile, so as to compress it. He then takes mould of wood, strengthened with iron and with i cutting edges, and puts it on the tile which he cuts the size. The mould is of course wetted each time i used. The tiles are then regularly dried. In Switz and and Alsace an iron mould is used.

IV.—TILE-KILNS.

The tile-kiln is generally within a building, and about
; ft. long (in ordinary dimension), 10 ft. wide, and
) ft. high. The walls are from 4½ ft. to 5 ft. thick,
cured outside with great beams, and so secured to-
ther as to form a square frame. Some of the largest
them are pierced with four flue-holes, as in brick-
lns; but the flues are formed by a series of brick
ches, about 2½ ft. wide by 16 in. high. The opening
the flue-hole is about 10 in. by 8 or 9 in. high. On
eir upper surface, these series of arches form a kind
grating, on which the tiles are laid. The kiln is
vered in at top with a brick arch, pierced with holes
different sizes. The kilns are charged from an open-
g which is constructed in one of the side walls, which
ening is, of course, during the burning, blocked up
d well secured. The fuel used is turf, as in the brick-
lns, and the fire is kept up for forty hours together,
hich is considered enough for the burning. Three
ys are then allowed for cooling, and they are after-
ards taken out of the kiln. Those tiles which are to
made of a greyish colour are thus treated. It having
en ascertained that the tiles are burnt enough, and
hile still red hot, a quantity of small fagots of green
der with the leaves on is introduced into each flue.
he flue-holes are then well secured, and the holes in
e roof each stopped with a paving tile, and the whole
rface is covered with 4 in. or 5 in. of sand, on which
quantity of water is thrown, to prevent the smoke
om escaping anywhere. It is this smoke which
ves the grey colour to the tiles, both internally and
ternally. The kiln is then left closed for a week, when
e sand is taken off the top, the door and roof-holes

are opened, as also the flue-holes, and the chareo produced by the fagots taken out. Forty-eight hou after, the kiln is cool enough to allow of the tiles bein taken out, and the kiln charged again. Whenever ar of the tiles are to be glazed, they are varnished aft they are baked; the glaze being put on, the tiles a put in a potter's oven till the composition begins run. The glaze is generally made from what are calle lead ashes, being lead melted and stirred with a lad till it is reduced to ashes or dross, which is then sifte and the refuse ground on a stone and resifted. Th is mixed with pounded calcined flints. A glaze manganese is also sometimes employed, which gives smoke-brown colour. Iron filings produce black copper slag, green; smalt, blue. The tile being wette the composition is laid on from a sieve.

The manufacture of tiles, as already observed, principally carried on near Utrecht, in the province Holland, which, like most of the great cities of Ho land, has facilities for the transportation of its produ by water communication all over the country.

Gouda is a great seat of the pottery and tobacco-pi manufactures, of which formerly Holland had a virtu monopoly, with regard to foreign trade, exporting large Delft ware, Dutch porcelain, tobacco-pipes, brick Flanders' bricks, painted tiles, and paving tiles. Th manufacture of painted tiles, for the decoration of th old fireplaces, was very extensive; and an infinite variet of designs, principally on Scripture subjects, employe many humble artists. This, however, is almost of th past. The manufacture of tobacco-pipes was anoth great business, suitable to the consumption of tobacc by the Netherlanders. Gouda alone had, at or time, as many as 300 establishments for the pr

uction of this article of trade. The manufacture of
)bacco-pipes is still a large manufacture in England,
ıuch more considerable than is generally supposed;
hile manufactures of bricks and porcelain constitute a
;aple means of employment for many thousands of
ır population.

A great part of these descriptions, it will be seen,
.rictly apply to our own practice, and are trite enough
ıd trivial enough; but in matters of this kind, there
nothing lost by being too minute, and it is always
ıfe. In the present case, it is worth knowing these
ıings, for the sake of knowing that there is no
fference.

CHAPTER III

BRICKMAKING AS PRACTISED AT NOTTINGHAM.

1. The mode of making bricks at Nottingham and
e neighbourhood presents several peculiarities, of which
.e principal are:—

1st. The use of rollers for crushing the brick-earth.
2nd. The use of copper moulds.
3rd. The hacking of the bricks under cover.

2. The use of copper moulds is not confined to the
ımediate neighbourhood of Nottingham, but has been
r some years gradually extending to other districts,
.d will probably, sooner or later, become general
roughout the country for the manufacture of superior
.alities of bricks.

3. It may be proper here to say a few words on the
ject of grinding the clay, so generally practised
roughout Staffordshire, Derbyshire, Nottinghamshire,
d Lincolnshire, and probably in many other places.

In many brickworks the earth used is not pure cl but a very hard marl, which cannot be brought int state of plasticity by the ordinary processes of weath ing and tempering without bestowing upon it m time and labour than would be repaid by the value the manufactured article. The expedient of grind is, therefore, resorted to, which reduces the earth to state of fineness required, according to the number sets of rollers used, and the gauge to which they worked, all hard lumps and pieces of limestone,* wh would otherwise have to be picked out by hand, be crushed to powder, so as to be comparatively harml

4. The advantages and disadvantages of the use rollers may be thus briefly stated,—

1st. A great deal of valuable material is used wh could not be made available for brickmaking the ordinary processes.

2nd. The process of grinding, if properly c ducted, greatly assists the operations of temperer by bringing the earth into a fine sta quite free from hard lumps.

On the other hand:

The facilities afforded by the use of rollers for work up *everything* that is not too hard to be crushed them, induce many brickmakers to make bricks with proper regard to the nature of the material. A comn practice is to work the rollers to a wide gauge, so t comparatively large pieces of limestone are suffered pass through without being crushed by them. Wh this has been the case, it need hardly be said that bricks are worthless. They may appear sound,

* It may be necessary to explain, that all pebbles and hard stones be picked out by hand before grinding; where the brick earth us much mixed with gravel, the only resource is the use of the wash n

nay have a tolerable face, but rain and frost soon destroy hem, and, in situations where they are exposed to the veather, they will become completely perished in a very ew years.

5. The following description of the mode of making ricks at Nottingham will apply pretty faithfully to the ractice of the brick-yards for many miles round. It vill, of course, be understood that in no two yards is he manufacture carried on in exactly the same way; here being differences in the designs of the kilns, the rrangement of the buildings, and other points of etail, which may be regulated by local circumstances, r which, from the absence of any guiding principle, nay be left to chance; the general features, however, re the same in all cases.

6. *Brick-earth.*—The brickmakers of Nottingham nd its immediate vicinity derive their supplies of brick-arth from the strata of red marl overlying the red andstone on which the town is built, and which in its urn rests on the coal-measures, which make their ppearance at a short distance to the west of the town.

The banks of the river Trent present many good ections of these strata, as at the junction of the rivers Trent and Soar; where they are pierced by the Red Hill tunnel, on the line of the Midland Railway; and t Radcliff-on-Trent, where they form picturesque cliffs f a red colour covered with hanging wood; and they re exposed to view in many places in the immediate icinity of Nottingham, as in the cutting for the old oad over Ruddington Hill, in the Colwick cutting of he Nottingham and Lincoln Railway, and Goose Wong Road, leading to Mapperly Plains.

The marl abounds with loose and thin layers of *skerry*, or impure limestone, and in many places contains veins

of gypsum, or, as it is called, *plaster stone*, which are extensively worked near Newark, and other places, for the manufacture of plaster of Paris.

The water from the wells dug in these strata is strongly impregnated with lime.

7. The colour of the bricks made at Nottingham and in the neighbourhood is very various. For making red bricks the clay is selected with care, and particular beds only are used. For common bricks the earth is taken as it comes, and the colour is very irregular and unsatisfactory, varying from a dull red to a dirty straw colour. Some of the marl burns of a creamy white tint, and has been lately used with much success in making ornamental copings and other white ware.

8. In the manufacture of common bricks no care is taken in the selection of the clay, and it is worked up as it comes to hand indiscriminately, the great object of the manufacturer being to clear his yard; the same price being paid for all clay used, whatever its quality.

Stones and pebbles are picked out by hand, but the pieces of limestone are generally left to be crushed by the rollers, and much bad material is worked up in this way which could not be made use of if the tempering were effected by treading and spade labour only.

There are, however, many beds which are sufficiently free from limestone not to require grinding, and when these are worked the rollers are not used.

9. For front bricks, and the superior qualities, the clay is selected with more or less care, receives more preparation previous to grinding, is ground finer, and is sometimes left to mellow in cellars for a considerable time before using.

10. For making rubbers for gauged arches, the clay is carefully picked, and run through a wash-mill into

its, where it remains until by evaporation and settle-
nent it has attained a proper degree of consistency.
'he clay for this purpose is generally mixed with a cer-
ain quantity of sand to diminish the labour of rubbing
he bricks to gauge, the proportion varying according
o the quality of the clay. The sand used for this
urpose is the common rock sand, which burns of a
ed colour.

11. The clay immediately near the town of Notting-
am is not well suited for making roofing tiles, the
are produced from it being generally very porous.
'his statement, however, is not to be taken without
xceptions, as there is plenty of suitable clay for the
urpose within a few miles' distance.

12. The old houses in Nottingham are built with very
hin bricks, much of the old brickwork gauging 10½ in.
o 4 courses in height, including mortar joints. These
ricks are of a dark red colour, and were from works
hat have been long since abandoned. The bricks now
nade are much thicker, the walls of many new build-
ngs gauging 21 in. to 7 courses in height, or about
3⅛ in. to 4 courses in height, including mortar joints.
'he common bricks are of a very uneven colour, which
rises partly from the manner in which they are set in
he kiln, and partly from the want of care in selecting
he clay, and the quantity of limestone ground up with
. From this circumstance the fronts of many of the
ew buildings have a mottled appearance, which is
xtremely unsightly.

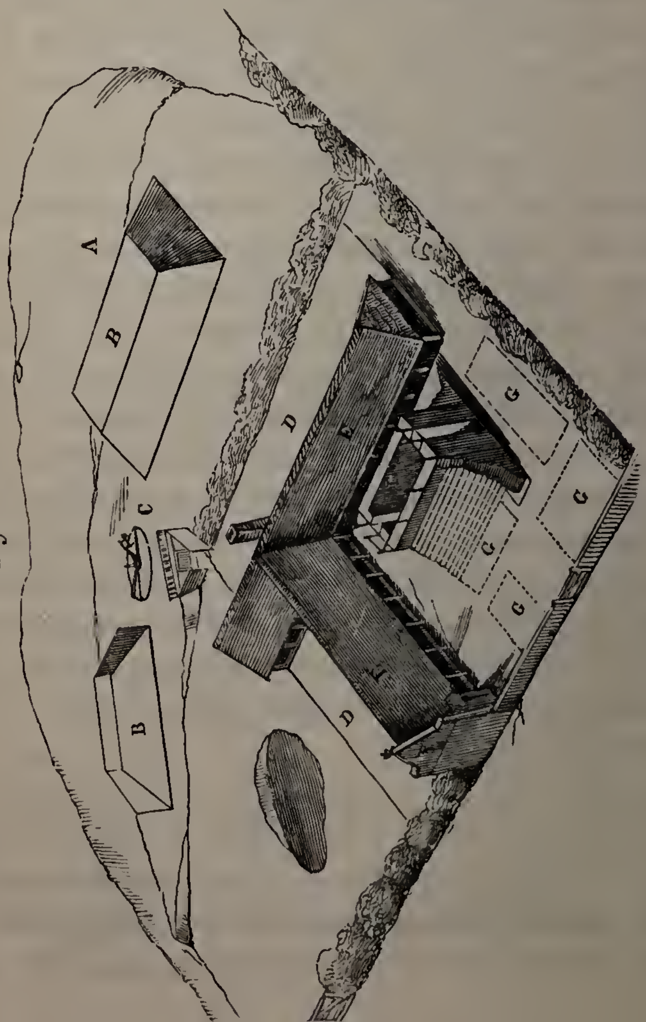
GENERAL ARRANGEMENT OF A BRICKWORK.

13. The brick-yards from which the town of Not-
ingham is at present supplied are situated on the
lopes of a small valley along which runs the public

road from Nottingham to Southwell, and, being situated on the sides of the hills, great facilities exist for draining the workings and for bringing the ground into cultivation again after the clay has been exhausted.

14. The proprietor of a brickwork usually rents the required land from the owner of the soil, at a price per acre, and in addition to the rent pays for all clay dug, whatever its quality, at a set price per thousand bricks made and sold, exclusive of those used for the erection and repairs of the buildings and works.

Fig. 1.*



* A more particular description of the engravings will be found at pages 92—94.

15. The arrangement of the several buildings varies ith each yard more or less; but the principle on hich they are laid out is the same in all cases, viz., to lvance towards the kiln at each process, so as to avoid l unnecessary labour. This will be understood by spection of fig. 1, which, it must be understood, is not ı exact representation of a particular brickwork, but a agram to explain the principle of arrangement usually llowed. The pits from which the clay is dug are at e rear of the works, and at some little distance from em is placed the clay-mill, which, to save labour in heeling the clay, is shifted from time to time as the orkings recede from the kiln by the exhaustion of the ay. This is, however, not always done, as, where the ill has been fixed in a substantial manner, the saving labour would not repay the cost of re-erection.

The hovel or drying shed generally forms two sides a rectangular yard adjoining the public road, the ln being placed as close to the hovel as practicable, ıd the working floors or flats in the rear of the latter. y this concentration of plan, the distance to which e bricks have to be carried between the successive ocesses of moulding, drying, hacking and burning is duced to a minimum, which is an important point to attended to, as the raw bricks are shifted by hand ıd not barrowed.

As it is not always possible to obtain a supply of ıter at those parts of the works where it is wanted be used, a water-cart* is kept at some yards for this ırpose, the supply being taken from a pond into which e drainage of the works is conducted.

* The water-cart is seldom used, except where the water has to be ched a considerable distance—indeed rarely, but in times of drought. is usually carried, in the yard, in buckets with yokes, as in the time of araoh.

The goods for sale are stacked in the open part o the yard as near the public road as practicable.

16. *Clay-Mill.*—The machinery used in grinding th clay is very simple. The clay-mill consists of one o more pairs of cast-iron rollers, set very close togethe in a horizontal position, and driven by a horse wh walks in a circular track; and, by means of the beam t which he is attached, puts in motion a horizontal bevelle driving-wheel placed at the centre of the horse track A horizontal shaft connected at one end with one c the rollers by a universal joint, and having a bevelle pinion at the other end, communicates the motion c the driving-wheel to the rollers by spur-wheels keye on their axles. The clay is tipped in a wooden hoppe placed over the rollers, and passing slowly between th latter falls on a floor about 8 feet below them, wher it is tempered for the moulder.

17. The common clay-mill has only one set of rollers but the addition of a second set is a great improvement In this case the bottom rollers are placed almost i contact with each other, and should be faced in th lathe to make them perfectly true. If only one set b used this is a useless expense, as the gauge to whic they are worked is too wide for any advantage to b derived from it.

18. Figures 2, 3, 4 represent a one-horse mill wit a single pair of rollers 18 in. in diameter, and 30 in long, manufactured by Messrs. Clayton and Shuttle worth, of Lincoln, who kindly furnished the drawing from which the engravings have been made. Th detailed description of the several parts will be foun in art. 69.

Fig. 2

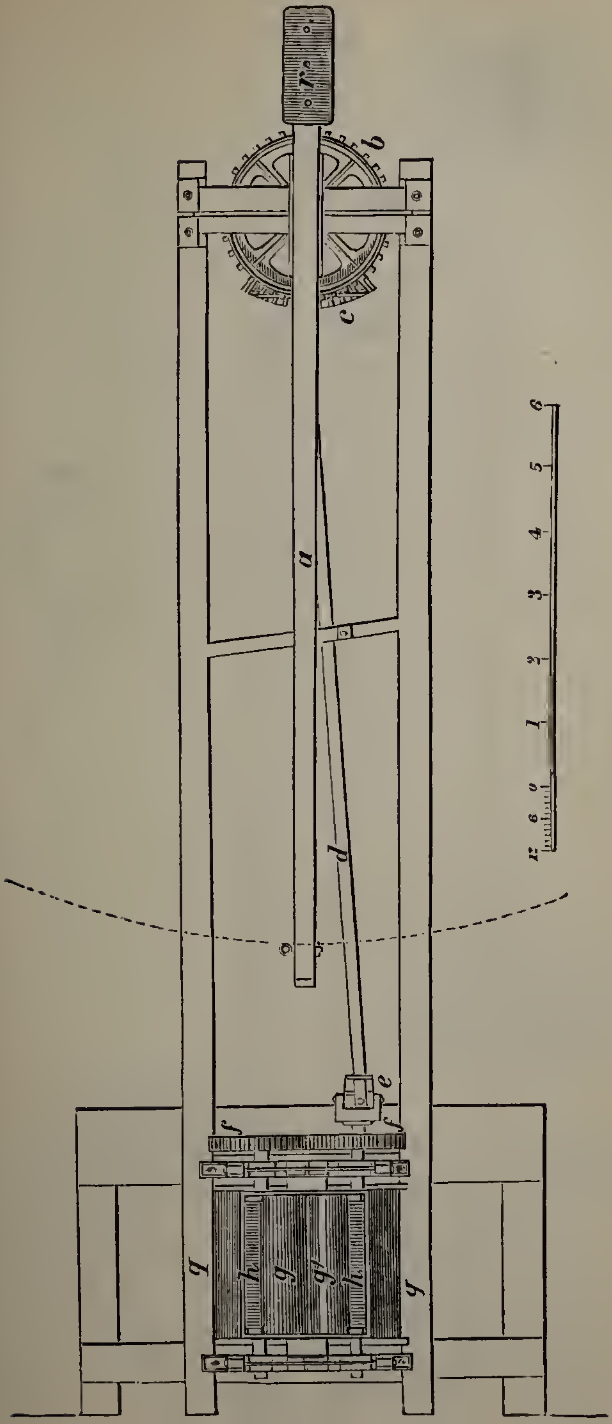


Fig. 3.

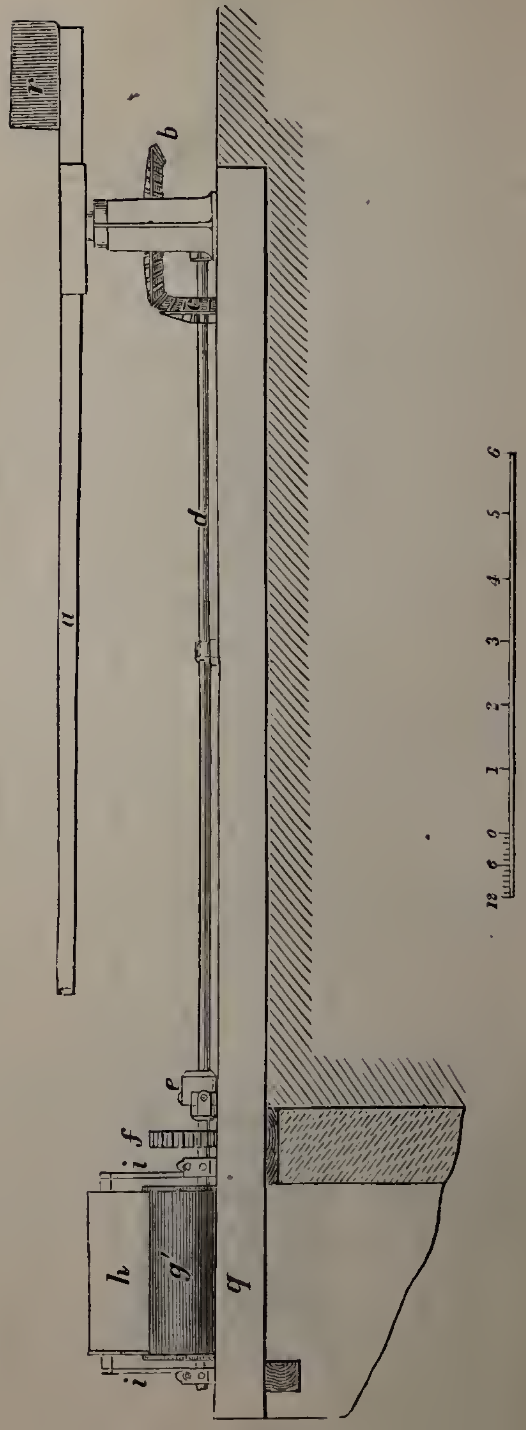
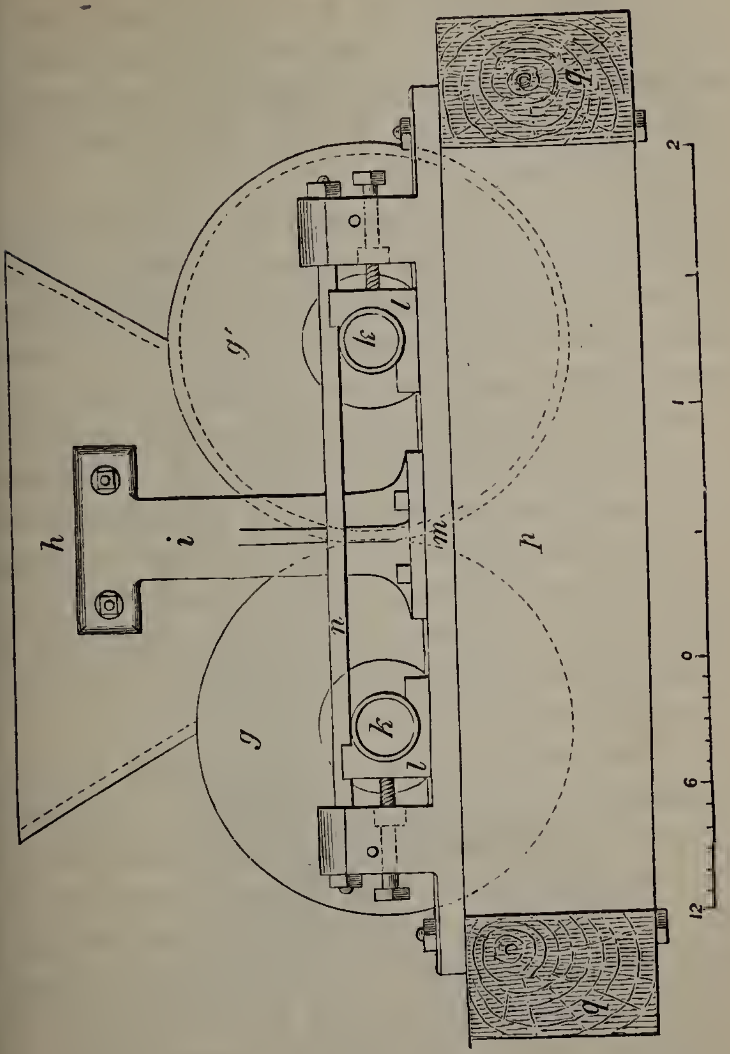


Fig. 4.



This is a very good mill, of simple construction, and ot expensive, the cost when ready for fixing (exclusive foundations and brickwork) being £35.

It cannot be too strongly insisted upon that the achinery should be boxed up close, so as to prevent ones or clay from clogging the wheels, as where this

is not done the machinery will unavoidably becom deranged in a very short time.

19. In many yards, the horse-track is raised to th level of the top of the hopper, so that none of th machinery is exposed. A very good arrangement c this kind is shown in fig. 5, of which a detailed descrip tion is given in art. 69.

20. The quantity of work performed will of cours vary greatly, according to the distance between th rollers and the consequent fineness to which the clay i ground. One mill will grind sufficient clay to keep si moulders fully employed, and therefore there are ver few yards in which the rollers are constantly in work.

21. The length of time during which a clay-mill wi last in good working condition is chiefly regulated b the wear of the rollers. If the iron is of very uniforr quality, and care be taken to pick out all the pebble from the clay, a pair of rollers will last many years The other parts of the machinery will last with care fo an indefinite length of time.

22. *Wash-mill.*—The wash-mill is used only in th manufacture of arch bricks, and does not differ fror that used in other places. The only one visited by th author consists of a circular trough, lined with brick work, in which the clay is cut and stirred up witl upright knives fastened to a horse-beam. From thi trough, the slip runs through a grating into a bricl tank, where it remains until by evaporation and settle ment it becomes sufficiently consolidated for use.

23. *The Pug-mill* is not used in the Nottingham* brick-yards; the tempering of the clay, after grinding being effected by treading and spade labour. Insteac of the clay being tempered directly after grinding, it is

* It is, however, used in the neighbourhood.

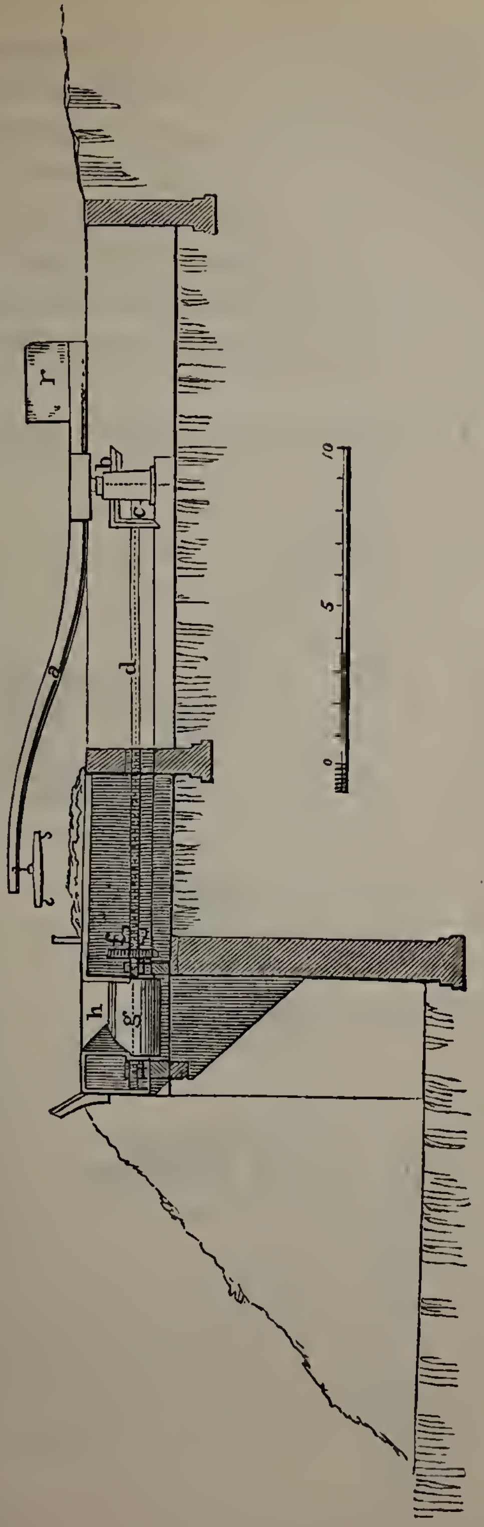


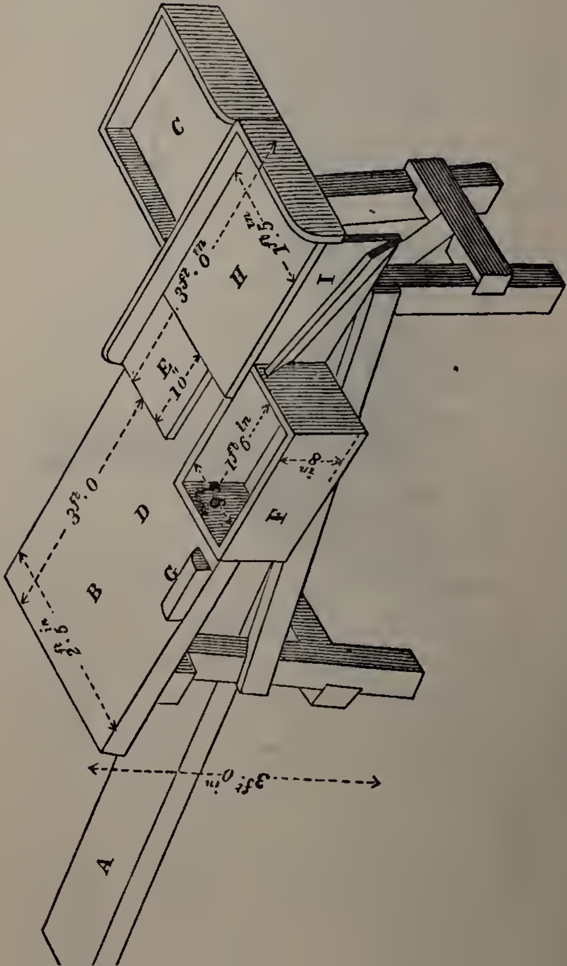
Fig. 5.

sometimes deposited to ripen in damp cellars for a ye
or more. This is donc for the best bricks only.

24. *The Moulding Sand* used is the common ro
sand, which burns of a red colour. In making whi
bricks this is a great disadvantage, as it causes r
streaks, which greatly injure their colour. The sand
only used to sprinkle upon the table to prevent the cl
from adhering thereto, and therefore sand with a sha
grit is preferred.

25. *The Moulding Table* is shown in fig. 6. It

Fig. 6.



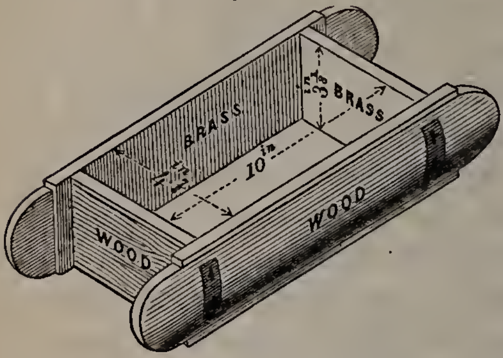
nished with a sand-box, which is sometimes fixed to table, as shown in the cut, and sometimes detached, l with a water-box, in which the moulder dips his nds every time he moulds a brick. In the operation moulding, the moulder stands in front of the table, h the water-box immediately in front of him, the npered clay at his right hand, and the sand-box at left. A sloping plank is placed at one end of the le to enable the boy who brings the clay from the nperer to deposit it more conveniently on the table. e boy who takes off the newly-made bricks, and ngs back the empty mould, stands on the side of the le opposite the moulder, to the right of the water-, in which he washes his hands after each journey, prevent the clay from drying on them.

The cost of a moulding table varies according to the e with which it is made. Such a one as shown in cut will cost about 20*s.*, and will last, with occasional airs, for several years. The part where the brick is ulded soon becomes worn, and has to be cased as wn in the cut. This casing extends over the part ere the brick is taken off by the carrier boy; but, as wear is not uniform over this space, the casing is in or more pieces, the part where the brick is moulded ring much faster than the others, and requiring ewal sooner.

t is of importance that the drippings from the table uld not fall on the drying floor, as they would render lippery and unfit for use; a rim is therefore placed one end, and along a part of one side of the table, the opposite side is furnished with a kind of apron gutter, by means of which the slush is conducted to b placed under one corner of the table, but which is shown in the cut.

26. *Brick Moulds.*—Until lately the moulds us were made of wood, but these have been almost entir superseded by brass, or, as they are technically call copper, moulds.

Fig. 7.



There are seve different ways which these moul are made. Som times the brass wo is merely an insi lining, screwed to wooden mould; b the best constructi appears to be th shown in fig. 7, in which the mould is of brass, cast four pieces, and riveted together at the angles, the woo work being in four distinct pieces and attached to t brass mould by the angle rivets. These moulds costly, and formerly a pair of moulds cost £2, but th may now be had for £1 5*s*. the pair.

It will be seen, by reference to the engraving, that brass overlaps the woodwork all round the mould each side, and these portions of the mould wear aw very rapidly, so that the bricks made at the close of season are considerably thinner than those made at commencement. This renders it necessary to renew projecting rims from time to time as they become wo down with use, and this will require to be done ev season if the mould has been in constant use. It is expensive operation, as the new rim has to be brazed to the old part, and this must be done with great nice and so as to make a perfectly flush joint on the ins of the mould, or the latter would be rendered usel The cost of *plating* a pair of moulds is nearly the sa

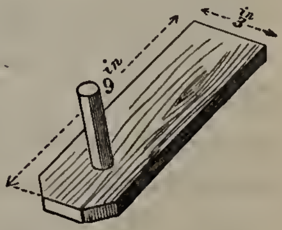
ıeir original cost, 20*s*. being charged for the opera-, and therefore it would be preferable to use the lds until they are quite worn out, and then to replace ı with new ones.

'. The use of copper moulds is confined to the ing of building bricks, and quarries for paving s, their weight and great cost preventing their loyment for larger articles.

. The mould has no bottom as in the London tice, nor is it placed upon a raised moulding board ı Staffordshire; but rests on the moulding table f, the top and bottom beds of the brick being formed vo distinct operations with a little instrument called ıne.

). *The Plane*, fig. 8, is usually e 9 in. long by 3 in. broad, a handle at one end. Its use ɔ compress the clay in the ld, and to work over the top bottom beds of the brick to them an even surface.

Fig. 8.



he strike is not used at Nottingham.

). *The Flats*, or working floors, are prepared with , by levelling and rolling, so as to make them hard even, and are laid out with a slight fall, so that no r may lodge on them. They are well sanded, and tant care is requisite to keep them free from weeds. r usual width is about 10 yards. In unfavourable her a single moulder will sometimes have as many 000 bricks on the flats at once, for which an area om 300 to 400 superficial yards will be required. , however, is an extreme case, and in good drying her a moulder does not require more than half that ıt of floor, or even less than this.

31. *The Hovel,* or drying shed, in which the bric are hacked, is generally built in the roughest a cheapest manner possible, with open sides and a til roof, supported by wooden posts or brick piers; t width of the hovel is about 18 ft., or rather more th the length of a hack, but the eaves are made to proj a couple of feet or so beyond this distance, in order give additional shelter from the rain, for which reas as well as for the sake of economy, the eaves are carr down so low as to make it necessary to stoop to en the shed.

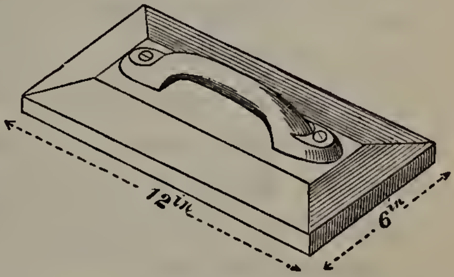
Some of the hovels have flues under the floor, t fire-places being placed in a pit sunk at one end of t hovel, and the chimney at the opposite end. Th flues are made use of when the demand for bricks so great that sufficient time cannot be allowed for d ing in the open air, and also during inclement seaso The sides of the hovel are then walled up with lo brickwork to retain the heat. No specific rule can given for the relative sizes of the hovel and the dry floor. The common practice appears to be to ma them of the same length, which allows ample roo and enables the moulder to keep a portion of his sl always available as a drying floor when the weather too wet to allow of the bricks being laid out on flats. When this is the case the moulder protects raw bricks from drafts, by surrounding them wit skirting, so to speak, of planks. This is a very nec sary precaution, for the currents of air from differ parts of the shed would cause the bricks to dry equally, and they would crack and become unsou Matting is frequently hung up at the sides of the ho for this purpose, and is also much used in some ya to prevent the finer clays, when tempered, from dry

rapidly where cellars are not provided for that
pose.

2. The above description applies to the ordinary el, but the best front bricks are dried wholly under er in a brick hovel inclosed by walls on all sides, furnished with flues, by which the place is kept ı regular temperature. The expense, however, of ducting the whole of the drying under cover in manner is too great to allow of its general adop-..

3. *The clapper*, fig. 9, mply a piece of board in. by 6 in. with a dle on one side. It sed to flatten the surs of the bricks as lie on the floors, the bricks are also

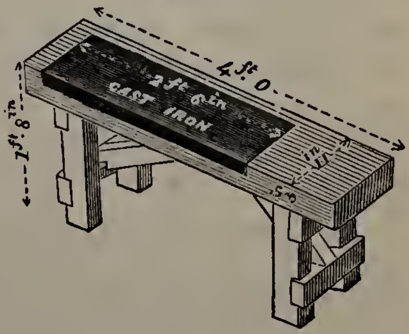
Fig. 9.



en with it during the process of hacking, to correct warping which may have taken place in the first e of drying.

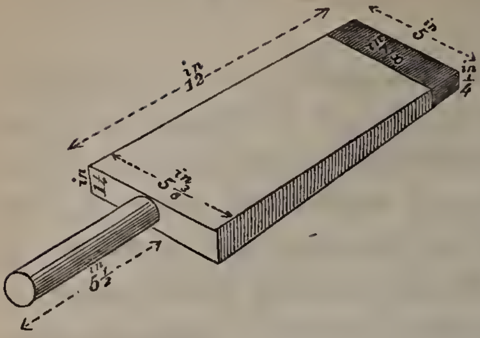
4. *Dressing Bench.*— . 10. This is simply a t bench, to which is d a plate of cast-iron, which the best front ks are rubbed or *po-ed*, to make them perly true and even; the kman, at the same time,

Fig. 10.



ting them with a wedge-shaped beater, tipped with , called a *dresser*, fig. 11. This operation toughens brick, corrects any warping which may have taken e, and leaves the arrises very sharp.

Fig. 11.



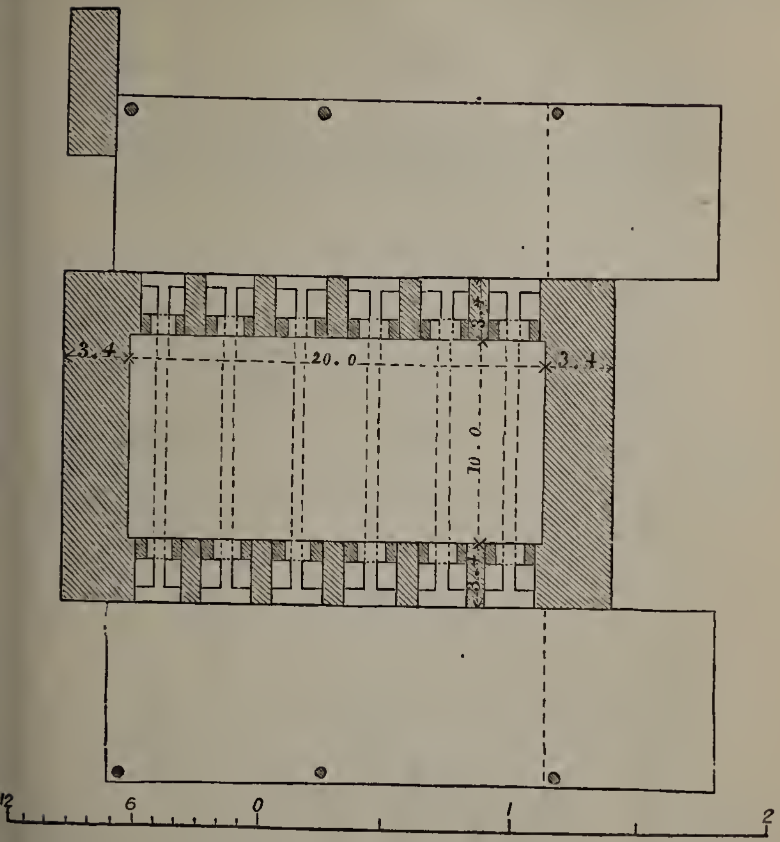
35. *Machinery f pressing Bricks.*—] some yards scre presses are used f pressing front bricl and with consideral success. It is, howeve questionable wheth they are as durable those dressed by hand. In making machinery for tl purpose the great desiderata are, 1st, to make the me mould in which the brick is compressed so strong tl it shall not spring on the application of the power; a 2nd, that the piston shall exactly fit the mould: wh from bad workmanship or long use, this is not the ca the clay is forced between the piston and the mould a short distance, leaving a slightly-raised edge all rou the side of the brick.

36. We do not propose here to enter upon a co parison of the respective merits of machine-pres bricks and those dressed by hand. The operation dressing on the bench requires an experienced wo man, whilst a common labourer can use a machi For this reason machine-pressed bricks can be p duced much cheaper than those dressed by ha and there is little inducement to employ the lat process.

37. *Kiln.*—The kilns vary considerably as rega their dimensions and constructive details, but they all built on the same principle.

The kiln shown in figs. 12, 13, 14, 15, 16, and 17 a good one, though rather weak at the angles, will serve to convey an idea of the general constr tion.

Fig. 12.



It consists of four upright walls, inclosing a rectangu-
chamber. The floor is sunk about 4 ft. below the
neral surface of the ground, and is not paved. The
orways for setting and drawing the kiln are merely
rrow openings at the ends of the kiln, raised a step
ove the ground, and about 5 ft. from the floor. The
e-holes are arched openings opposite each other on
e sides of the kiln, lined with fire bricks, which require
be renewed from time to time, generally every season.
ne width of these holes is reduced to the required space

by temporary piers of brickwork, so as to leave narrow opening about 8 in. wide and about 3 ft. high This will be understood by reference to fig. 12, in whic

Fig. 13.

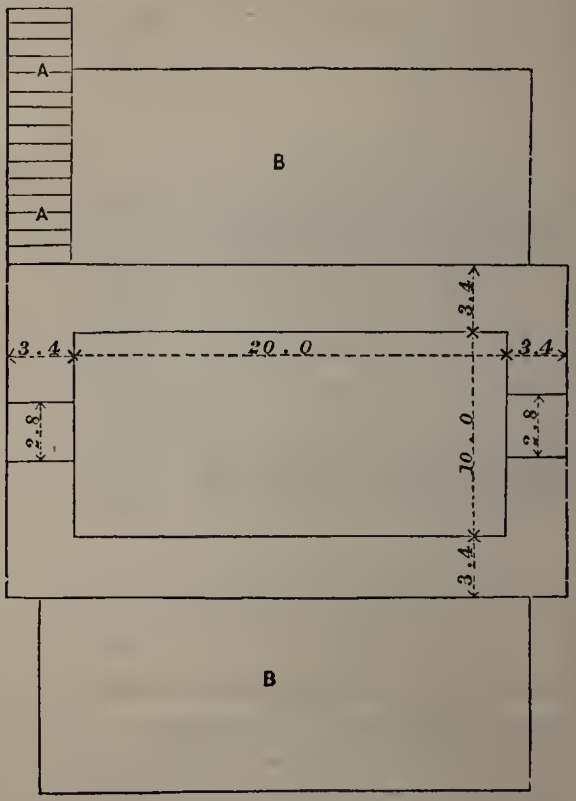


Fig. 14.

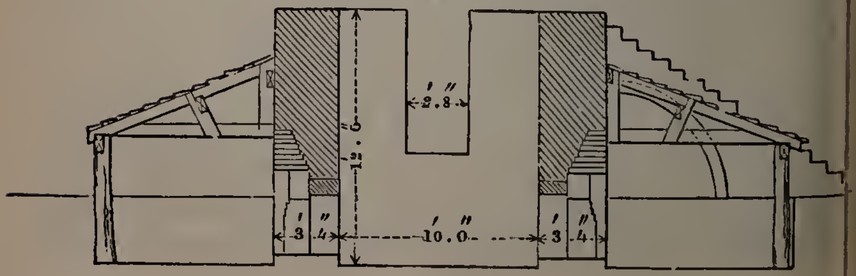


Fig. 15.

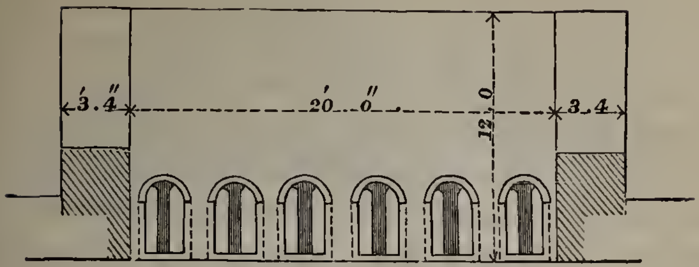


Fig. 16.

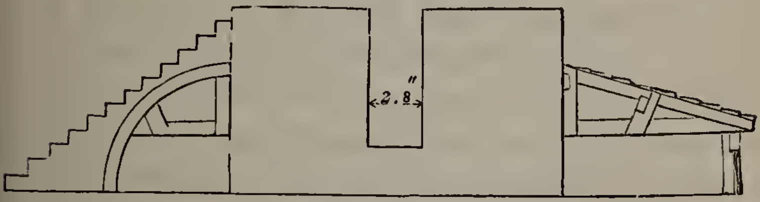
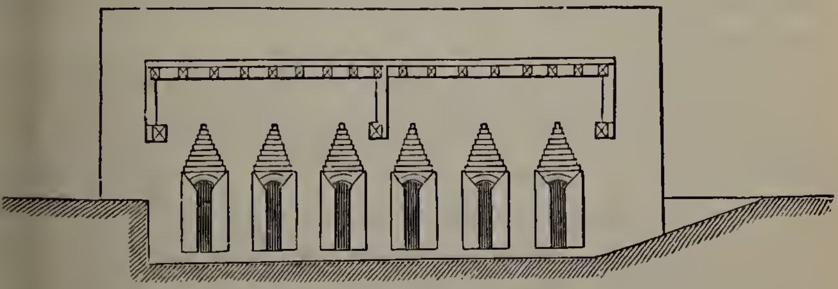


Fig. 17.



he dark shading shows the fire-brick lining, and the nshaded parts the temporary piers.

On each side of the kiln a pit is sunk to the level of he floor, and covered with a lean-to roof, which protects he fuel and the fire-man from the weather, and prevents he wind from setting against the fires. The walls of he kiln are about 3 ft. thick, and are built of old bricks, ubble stone, and the refuse of the yard. No mortar is sed, as the use of lime would destroy the brickwork,

under the intense heat to which the walls are exposed. The bricks are therefore set in loam or fire-clay, if it can be readily procured. The fire-bricks for lining the fire-holes are sometimes brought from Ilkeston, where excellent fire-clay is worked, but it is most common to make them at the yards with such clay as can be got in the neighbourhood, which answers pretty well. This clay is brought from the neighbouring collieries, and is obtained when sinking shafts; there is no fire-clay at any of the Nottingham yards.

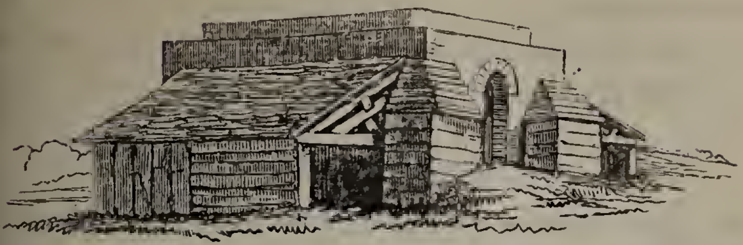
38. Instead of being built with walls of parallel thickness, resting on arches, as in the example just described, some kilns are built with walls of great thickness at bottom, and diminishing by set-offs until near the top of the kiln, they are comparatively thin. Many kilns also are provided with massive buttresses at the angles, with the intention of counteracting the tendency which the walls have to lift themselves with the heat.

Very great care is requisite in drying a newly-built kiln, or the walls will be cracked at the first firing, and the thicker the walls the greater the care necessary.

39. So long as the brickwork is sufficiently thick to retain the heat, no purpose is attained by increasing the strength of the walls, unless they are made so massive that they are unaffected by the heat externally and heavy enough to counteract the *lifting* cause by the expansion of the sides exposed to the fire. In the one case the walls expand bodily with the heat, forming large and dangerous cracks; in the other, separation takes place between the inside and outside of the walls from the expansion of the parts most exposed to the heat, and the kiln soon requires relining.

40. The kiln shown in figs. 12 to 17 is an example

Fig. 18.



the mode of building with walls of the same thick-
ss top and bottom; that shown in fig. 18 is one of a
re massive construction, and has buttresses at the
gles. The upper part of this kiln is formed by build-
;, in a temporary manner, a thin parapet round the
ide of the top of the walls, about a couple of feet in
ight. This expedient is often resorted to for the sake
increasing the capacity of a kiln at a small expense.
41. Some of the kilns are provided with a flight of
ps by which access is obtained to the top, in others
lders are used for this purpose. Many of the kilns
ve also a kind of light fence round the top, made of
igh poles. This serves as a protection from falling,
d as a scaffold to which screens may be hung in
ndy weather to keep the wind from setting on the
of the kiln. This fence is shown in fig. 2. The
tside staircase is shown in figs. 1, 13, and 16.
42. The sizes of the kilns vary considerably. A
n such as that shown in figs. 12 to 17, 20 ft. long,
wide, and 12 ft. high, will, with the addition of a
apet, burn 25,000 bricks at once, and will require
her more than that number of bricks for its erection.
e cost of such a kiln would be from £30 to £50, the
ue of the materials being almost nominal.
The capacity of a kiln may be roughly calculated on
assumption that ten bricks require a cubic foot of
ce in the kiln, but much, of course, will depend on

the nature of the clay and the amount of shrinkag before burning.

43. A well-built kiln will last for many years wit occasional repairs.

PROCESS OF BRICKMAKING.

44. *Clay digging.*—The clay or marl is, or should b dug in the autumn, and collected in large heaps at th bottom of the slopes, to be mellowed by the winter frost These heaps are shown in fig. 1.

The cost of this operation varies from 1*s*. to 1*s*. 9 per 1,000 bricks, according to the labour of getting th clay, and the distance to which it has to be wheeled.

45. *Tempering.*—In the spring the clay is turned ov by spade labour, being at the same time well watere and trodden. The pebbles and large lumps of lim stone are picked out by hand with more or less car The prepared clay is then wheeled to the mill, an tipped into the hopper. Sometimes the clay, aft being ground, is at once tempered for use on the floo beneath the rollers; but for the best bricks, as befo stated, it is allowed to remain in cellars to ripen for year or more.

46. The temperer is generally paid by the mould who contracts for tempering, moulding, and hacking a price per 1,000. The cost of tempering for commo bricks is about 1*s*. 3*d*., exclusive of the cost of horsin the mill, which is borne by the proprietor of the yard.

One temperer will keep one moulding-table constant supplied, and will also assist the moulder in getting u his bricks from the floor.

47. *Moulding.*—A sufficient quantity of clay havin been prepared on the tempering floor, one of th moulder's boys takes up as large a lump as he ca

onveniently carry, and, placing it on his head, walks rith it to the moulding table, and walking up the loping plank, deposits it at the end of the table, to the ight hand of the moulder at B, fig. 6.

The moulder having sprinkled some dry sand over he part of the table marked D, takes from the heap of empered clay a piece sufficient to make a brick, and neads this clot with his hands on the sanded part of he table, so as to bring it approximately into shape. Ie then raises the clot in the air, and dashes it with ome force into the mould, striking off the superfluous lay with his fingers. He then dips his hands into the rater-box, and, with very wet hands, works over the ace of the brick, so as to force the clay perfectly into ne mould in every part. He next takes the plane and asses it backwards and forwards with considerable ressure, until the face of the brick is flush with the dges of the mould, and then, reversing the mould, lanes the underside in the same way. The brick being oulded, the moulder slides it on the wet table to his ft hand side, where it is taken off by a second boy, ho carries it, mould and all, to an unoccupied part of ne floor, where he turns it out carefully on one of its des, and returns with the empty mould. Meanwhile ne moulder has made another brick in a second mould, hich is now ready to be taken off, and this process is epeated until the distance to an unoccupied part of ne floor is too great to allow of the boys returning in me, and the table is then shifted to another part of ne floor.

48. *Drying.*—After the bricks have remained for a w hours in the position in which they were first placed n the floors, they are turned on their edges by a boy, ho turns up two at once, one with each hand. They

remain in this position a few hours longer, and are then laid flat on the opposite side to that on which they were first placed. Careful moulders sprinkle sand over the wet bricks as they lie on the floor, which absorbs the superabundant moisture, and renders them less liable to crack; but this is not always done.

The new bricks sometimes also undergo a slight dressing with the clapper, to take off any roughness at the edges, and to correct any alteration of form which may have taken place on turning them out of the mould, and in some cases they are scraped with a small iron scraper, to remove any dirt that may adhere to them.

After lying flat a few hours longer, they are carried by the boys, three at a time, to the hovel, where the moulder builds them into hacks 50 bricks long and 14 courses high, each hack containing 700 bricks. As the bricks are hacked they are *batted* with the clapper, to correct any warping which may have taken place whilst lying on the floors. The bricks remain in the hovel without being again shifted, until they are ready for burning.

49. The time allowed for drying varies with the weather, the size of the kiln, and the demand for bricks. Some brickmakers get the bricks out of the kiln within a fortnight of their leaving the moulds, but this haste is very prejudicial to the soundness of the bricks, and, as a general rule, three weeks is the least time that should be allowed for drying.

The time that the raw bricks lie on the flats depends solely on the weather. In good drying weather the bricks are made one day and hacked the next; but at other times several days may elapse before they are fit for hacking.

50. It is not very easy to separate the cost of hacking

om that of moulding, as both operations are performed by the moulder. The price for moulding, including tempering and hacking, is from 5*s.* per 1,000, nd upwards; 5*s.* 3*d.* is a common price. Where the lay is ground the moulder pays for feeding the mill, ut not for horsing it, this expense being borne by the roprietor of the yard.

51. The above description refers to the ordinary iode of proceeding, but for facing-bricks additional rocesses are employed. *Pressed bricks,* as their name nplies, are prepared by putting the raw bricks one at time, when nearly dry, into a metal mould, in which iey are forcibly compressed by the action of a powerful ver which forces up the piston forming the bottom of ie mould. This gives a very beautiful face to the rick, and leaves the arrises very sharp, but bricks so repared require longer time for drying and judicious ianagement in the kiln, otherwise they will be unound, and when exposed to the weather soon become erished.

52. *Polished bricks,* as they are called, are rubbed pon a bench plated with iron, to make their surfaces erfectly even, and are also dressed with a dresser, as efore described. This process is only gone through ith the very best bricks, and its cost is such that it is ot employed to any very great extent.

53. The contraction of the clay in drying is very ight, and no perceptible diminution of size takes lace in burning if the bricks have been previously ioroughly dried.

The brick moulds are made of different sizes at different yards, their proportions having been altered from me to time, so as to increase the depths of the moulds t the expense of the other dimensions.

When the thickness of a piece of brickwork is mea- sured by the number of bricks, as in house building, and not by feet and inches, as in building the piers of bridges and other solid works, the number of bricks required for the execution of a rod of brickwork is considerably reduced by a very trifling addition to the thickness of the bricks, and this is always an induce- ment to purchasers to prefer the yards where the deepest moulds are used.

The largest common bricks now made measure, when burnt, $9\frac{1}{2}$ in. long, $4\frac{5}{8}$ in. wide, and $3\frac{1}{16}$ in. thick, or thereabouts; the size of the moulds being $9\frac{7}{8}$ in. long by $4\frac{13}{16}$ in. wide, and $3\frac{3}{8}$ in. deep. These bricks weigh about 7 lbs. 15 oz. when burnt.

The best red facing-bricks made at Mr. Wood's yard in the Carlton Road, measure, when burnt, $9\frac{1}{8}$ in. long, $4\frac{1}{2}$ in. wide, and $2\frac{13}{16}$ in. thick. The moulds for these bricks are 10 in. long, $4\frac{7}{8}$ in. wide, and $3\frac{1}{8}$ in. deep.

54. A good moulder, if solely occupied in moulding, will turn out 2,000 bricks in a day, between 6 A.M. and 6 P.M.; but as nearly one-third of the moulder's time is taken up with hacking, the average day's work is not more than about 1,300 per day, or between 7,000 and 8,000 weekly.

55. *Burning.*—The setting of the kiln is an opera- tion on which much depends, and requires to be done by an experienced hand, as there is a great deal of art in arranging the bricks in a proper manner, so as to allow the heat to be diffused equally through the kiln, and to afford a proper draught, so as to obtain the greatest amount of steady heat with the smallest ex- penditure of fuel.

The lower part of the kiln is filled with common bricks, narrow openings being left, as shown by the

tted lines in fig. 12, forming flues connecting the posite fire-holes, the tops of these flues being formed oversetting the bricks on each side till they meet. iese flues are of the same height as the fire-holes.

The best bricks* are placed in the middle of the kiln, d above these again are placed common bricks up to e top. The bricks are not placed close together, but space is left all round each brick to allow of the passge of the heat round it; the bricks in the successive urses being crossed either slantwise, or at right angles each other. When a brick rests partly on others, d is partly exposed to the fire, the exposed part will nmonly be found of a lighter red than those to which fire has had no access, and this is one great cause the mottled colour of the Nottingham bricks. When, erefore, it is wished to produce bricks of a uniform l tint, great care is taken to keep the faces and ends the bricks in close contact, crossing them every few irses only.

The kiln being topped, the doorways are built up with use brick and plastered over with clay, to prevent admission of currents of cold air, and the fires being ited, the heat is got up gradually, care being taken to urge the fires, until all the steam is driven off m the bricks, and the actual burning begins. When fire has attained its full heat, the fire-holes are tially stopped with clay, and the top of the kiln is ered over with earth, turfs, or boards, to check the ught, and a steady uniform heat is kept up until completion of the burning, which generally occupies ee days and three nights from the first lighting of

* If tiles be burnt at the same time, which is frequently the case, as cannot be burnt alone without great waste, they take the same ion in the kiln as dressed bricks.

the fires; at the expiration of which time the fire-h
are completely stopped, and the fires put out; after
fires have been extinguished, the kiln should be allo
to cool very gradually, as the soundness of the brick
much deteriorated by the kiln being opened too so
this, however, is a point not sufficiently attended to

56. The fuel employed is coal,* the quantity† u
being about half a ton per 1,000 bricks, the e
amount depending on the quality of the fuel and
judicious setting of the kiln. The town of Notting
being situated on the very edge of the Nottinghams
coal-field, the cost of firing is very low, and excel
coal can be laid down at the yards at from 8*s*. 6*d*.
ton upwards. The small coal or *slack* frequently u
in the early stage of burning does not cost more t
5*s*. to 6*s*. per ton.

57. The colour and soundness of the bricks v
according to their position in the kiln and the inten
of the heat to which they have been exposed. Th
nearest the fire become partially vitrified, and
blackish tint. Those which have been more favour
placed burn of various tints according to the natur
the clay, from red to straw colour and white, and w
struck together ring with a clear metallic sound. T
which are underburnt are tender, of a pale red col
and give a dull sound when struck together.

58. The cost of setting and drawing the kiln is g
rally reckoned at 1*s*. 6*d*. per 1,000, this inclu
stacking the bricks in the yard, or placing the
the carts of the purchasers. If, however, they

* Soft coal is preferred.

† In some great yards a deal of coal is wasted on the top of th
As the heat has always an upward tendency, this has very little ef
the bricks, and a great deal of fuel is wasted in smoke and flame.

for immediate sale, an additional 6*d.* is charged for
ding the carts.

9. The labour in firing is reckoned at 1*s.* per
00.

0. At Nottingham, and at the yards in the neigh-
urhood, many varieties of brick are manufactured;
ant, or splayed bricks, for plinths; weathered and
oated copings of several sizes; round copings;
ks with quarter-round ends; wedge-shaped bricks
culverts; compass, or curved bricks for lining shafts
wells, and also paving, roofing, and draining tiles
ll descriptions. It is unnecessary to enter into any
ails on the manufacture of these articles, as they
r no particular points of interest. It may, however,
worth while to mention that the use of copper
ulds is confined to the manufacture of those articles
ch are of a convenient size, and for which there is
rge demand; the moulds for cant bricks, compass
ks, and other fancy articles for which there is only
mited demand, being made of wood.

COST OF MANUFACTURE.

1. *Land, and Brick-earth.*—The proprietor of a
kwork usually rents the necessary land at a price
acre, and in addition pays for all clay removed at a
price, whatever its quality.

s the brick-earth is exhausted, or the workings
h an inconvenient depth, the ground is levelled and
n thrown into cultivation. This is of course done
he earliest period possible; and in some cases the
al of the land is nearly made up by the profit de-
d from cultivating the site of the exhausted work-
, so that it is impossible to give an accurate estimate

of the proportion which the rental of the land bear the total cost of manufacture, as it must vary widel each particular case. This remark does not hold g with regard to the brick-earth, which is paid for at rate of 8*d.* per cubic yard, or 2*s.* per 1,000 brick thousand bricks requiring about 3 cubic yards of cl

It must be remembered that, as above stated, price is paid for all clay removed, whether suitabl not for brickmaking. For common bricks the eart taken as it comes, good and bad being ground up gether; the cost of grinding being less than the which would result from the rejection of the infe earths, which are often so hard, and contain so m skerry in pieces of all sizes from that of a walnut to of a man's head, that they could not be worked u the ordinary process of tempering by treading and sp labour only. For front bricks and the best quali the clay is carefully picked, and the cost is pro tionately increased thereby.

No estimate can be given for the amount of required for making a given number of bricks, a depends on the situation of the yard and the dept which the workings can be carried.

62. *Buildings and Machinery.*—From the circ stance that in existing yards the buildings have b erected at different times without any very system plan, it is not very easy to ascertain what are the relative sizes of working floors, hovels and kilns what extent of building and plant are required working a yard to the greatest advantage. Unless manufacture be conducted on a very large scale, grinding-mill will, in most cases, be often unemploy and the wash-mill being used only in the manufac of arch bricks, it is only in the immediate neighbo

ood of a large town that a return for the cost of its ection can be hoped for. It will always be found an vantage to have an excess of shed-room rather than e contrary.

63. The following rough estimate will give an idea of e buildings and machinery required for mounting new yard, to produce from 40,000 to 50,000 per eek :—

1 clay-mill.
120 yards lineal of hovel, 6 yards wide.
1,200 yards superficial of working floor.

This extent of hovel and floor will be sufficient for the erations of six moulders; and, taking the work of ch moulder to average throughout the season 1,300 r diem, the week's work of the six moulders would oduce 46,800 per week, or in round numbers 140,000 ery three weeks.

This rate of production would render necessary two ns, each to burn 35,000, and these kilns would be pt in constant activity, each kiln being fired twice ery three weeks.

64. For a yard in which it is proposed to make all nds of brick ware additional buildings will be required, :—

Cellars for ripening the ground clay;
A tempering shed, for tempering under cover;
One or more drying-houses, provided with furnaces d flues;
A wash-mill for running the clay for making rubbers.

Besides the above erections, there will be required in yards stabling to a greater or less extent; a cottage the under-taker of the yard; and sheds and out-ildings for keeping tools, carts, and implements.

65. *Tools.* — The tools required by each moulder are :—

A pair of brass moulds;
A moulding table, and appurtenances complete;
A plane;
A clapper.

In addition to these implements a variety of other articles are required, as shovels, picks, barrows, planks sand baskets, sieves, &c., which are kept in store by the proprietor of the yard, and supplied to the men as required.

66. *Labour.*—The proprietor of the yard finds all tools and implements, sand, and coals, and horses the mills. The general management of the yard is conducted by an under-taker, who superintends the yard and contracts with the proprietor for all the labour required in the actual manufacture, at a price per 1,000 on the tale of bricks delivered from the kiln the under-taker bearing all loss from frost, wet, or other causes.

The under-taker sublets the moulding to a moulder who contracts with him at a price per 1,000 to mould and hack the bricks ready for setting in the kiln; the moulder employing two boys to assist him in moulding and hacking, and also a temperer, who tempers the clay for him, and assists in getting up the bricks from the floor. The first turning over of the clay is performed by labourers, under the direction of the under-taker, who, with the assistance of a few boys and labourers, sets and draws the kilns himself, and attends to the burning.

67. The actual selling price of bricks is regulated more by the demand and the amount of competitio

ı by the cost of their production. Good building ks, made in copper moulds, may be had in Notting- at 25*s.* per 1,000; but a fair selling price may considered as 28*s.* per 1,000, which may be thus livided :—

		£	*s.*	*d.*
y digging	per 1,000	0	1	6
rning over and watering clay and feeding mill	"	0	0	8
nding	"	0	0	6
npering for moulder	"	0	0	4
ulding, drying and hacking . . .	"	0	4	0
ting and drawing kiln	"	0	1	6
ning	"	0	1	0
Total cost of labour . . .	"	0	9	6
l, half a ton, at 8*s.*	"	0	4	0
y, 5*s.* 10*d.* per 1,000, with 5 per cent. added	"	0	6	1½
y	"	0	2	0
t, tools, machinery, and profit . . .	"	0	6	4½
Selling price at yard . . .	"	1	8	0

is may be considered as the lowest price which afford any profit to the proprietor of the yard, proper allowance is made for depreciation in ings and machinery, tools, repairs, and other ngencies.

The relative value of the different qualities of may be thus stated :—

		£	*s.*	*d.*
mon bricks (the clay not picked) . .	per 1,000	1	8	0
t bricks (made in copper moulds, the clay cked)	"	1	13	0
shed bricks (made in copper moulds, the rth selected with care, and the bricks essed on a bench)	"	3	0	0

69. Reference to the Illustrations accompany the foregoing Account of Brickmaking as pr tised in Nottingham.

Fig. 1. General view of a brickwork, showing the arrangement o works.

A. The face of the workings.

B B. Heaps of brick-earth, dug in the autumn, to be worked u following season, after being mellowed by the winter frosts.

C. The clay-mill.

D D. The working floors, generally made about 9 or 10 yards

E. The hovel. This hovel is flued,—the door at the end of the l next the road is the entrance to the furnace pit; the chimney which the flues are conducted is shown at the opposite end. some drying houses the flues are made to return nearly t furnaces before they are led into the chimney, so that the lat close to the former.

F. The kiln. This form of kiln is a weak one, and is liable split from top to bottom by the expansion of the walls, from intense heat to which they are exposed. The reader will ob the steps and the wooden fence round the top of the walls, tioned in article 41.

G. Goods for sale.

This illustration is not an exact representation of any particular b work, but has been made up from the details of several yards, to sho principle on which they are laid out; which is, to save all unnece carriage of either brick-earth or bricks, from the time of first tu over the clay to the stacking of the finished bricks in the sale yard.

Figs. 2, 3, and 4. Clay-mill, with a single pair of rollers 1 in diameter, and 32 in. long, as manufactured by Messrs. Clayton Shuttleworth, of Lincoln. The letters of reference are the same in figure.

a. Horse beam, 12 feet long, from centre of horse track to cen driving wheel.

b. Bevelled driving wheel.

c. Pinion.

d. Driving shaft, $1\frac{1}{2}$ in. diameter.

e. Universal joint.

f f. Spur wheels.

g g′. Cast-iron rollers 18 in. diameter and 32 in. long. The marked *g′* is longer than the other, having a flange round end by which the roller *g* is kept in its proper position. roller marked *g′* is connected by the universal joint *e* wit driving shaft *d*.

h. Wooden hopper.

i i. Cast-iron standards to support the hopper.

k k. Axles of rollers.

l l. Bearings for the axles *k k.* These bearings are made to slide on the bottom plate *m*, in order that the gauge of the rollers may be adjusted at pleasure.

m. Bottom plate, on which the bearings rest.

n. Strengthening bar.

o o. Adjusting screws, by which the rollers can be set to any gauge, according to the degree of fineness to which the clay is required to be ground.

p. End beam of framing.

q q. Sides of framing.

r. Balance weight to horse beam.

ıe rollers in this mill are not faced in the lathe, but they are cast ;ht in loam moulds, which insures great accuracy in casting, and ːrs turning unnecessary, where only one set of rollers is employed. arrangement of the rollers, when two or more sets are employed, is n in chap. iv., figs. 1, 2, and 3, which shows the construction of the mills used in Staffordshire.

ıe temporary floor on which the clay falls after passing between the rs is formed about 8 feet below them, and is inclosed on three with brick walls which support the wooden framework of the ıinery. The clay is prevented from adhering to the surfaces of the rs by strong knives fixed on their under sides.

g. 5 is a diagram showing an improved arrangement of the ordinary mill, in which the horse track is raised to the level of the top of the er, the whole of the machinery under the hopper being completely d up, so that no dirt or stones can lodge on the wheels. The driving l is placed in a circular pit lined with brickwork to keep up the ː track to the required height.

g. 6. Isometrical view of a moulding table.

A. Sloping plank, placed at one end of the table to enable the moulder's boy to deposit the clay on the table.

B. End of the table where the tempered clay is deposited.

C. Sand box. This is not always fixed to the table. In many cases it is a detached box, on three legs, placed close to the moulding table.

D. The part of the table on which the clot is moulded.

E. The place where the clot is put into the mould.

F. The water-box, in which the moulder dips his hands each time he moulds a brick.

G. A slip of wood on which the plane rests in order to raise it from the table, that the moulder may take it up the more readily.

H. The part of the table at which the brick is taken off. This part of the table is always very wet, and the slush runs off into

. Gutter, to carry off the drippings from the table into a tub placed beneath it, but which is not shown in the drawing. If the water were allowed to run down on the working floor, the latter would soon become wet and slippery, and unfit for receiving the bricks.

:. 7. Copper brick mould.

This kind of mould is cast in four pieces and riveted together, the sides projecting half an inch beyond the ends. Each casting has a flange at top and bottom, forming a rim half an inch wide all round the top and bottom of the mould. These rims become

gradually worn down by the friction of the plane and the act
the moulding sand, and require replating from time to time.
expense of replating with brass has induced a trial of iron
but they have not been found to answer. The outside of the
is eased with wood, secured to the brass by the rivets. To
hold to the latter, each pair is passed through a piece of
copper, as shown in the cut.

The moulds for making quarries are somewhat different, two
sides only being cased with wood, whilst the others are st
by strengthening ribs cast on the sides of the mould.

Fig. 8. The plane.

Fig. 9. The clapper.

Fig. 10. Bench on which the best bricks are polished and dresse
a dresser, as described in art. 34.

Fig. 11. The dresser.

Figs. 12, 13, 14, 15, 16, and 17. Plans, sections and elevation
kiln.

Fig. 12. Plan at level of floor, showing the firing sheds and fire
The latter, in this example, are arched over, and are built
siderable width, which is afterwards reduced by temporary
brickwork. In many kilns, however, the fire-holes are n
onee of the requisite width, and finished at top by oversetti
brieks on eaeh side till they meet, instead of being arehe
The fire-brick lining to the fire-holes is indicated in the pl
tint darker than that of the rest of the walls. The tempora
of brickwork are shown in outline only. These are pulle
whenever the fire-briek lining requires to be renewed. T
of the kiln is not paved.

Fig. 13. Plan, showing the roofs of the firing sheds (B B), a
steps (A) leading to the top of the kiln.

Fig. 14. Cross section of kiln, taken through the firing she
showing the eonstruction of the fire-holes.

Fig. 15. Longitudinal section, taken through the doorways
ends of the kiln, and showing the appearance of the fire-h
the inside.

Fig. 16. End elevation of kiln, showing the doorway and the
the firing sheds, as well as the steps leading to the top of th

Fig. 17. Side elevation, with the firing shed removed, in o
show the fire-holes.

Fig. 18. Perspeetive view of a kiln. This kiln is built very dif
from that shown in the previous figures, the walls being very
at the bottom, and diminishing in thiekness as they ascen
angles are strengthened by buttresses. The doorways do n
to the top of the walls, and are arched over, so that the latt
a continuous terrace all round the top of the kiln, on which
parapet is built up in a temporary manner, to increase its c

CHAPTER IV.

ЗRICKMAKING AS PRACTISED IN THE STAFFORDSHIRE POTTERIES. BY R. PROSSER, C.E.

. *Bricks.*—There are made in this neighbourhood following sorts of bricks for building, viz., red, blue, drab, and also a blue brick used as a paviour for ːways, which brick is called a dust brick, from the umstance of coal dust being used when it is moulded. en fired it has a smooth and somewhat glossy sur-, and being very durable is extensively used as a iour.

. The drab brick is used to a limited extent for ding, but more generally as a fire-brick by potters iron-masters; it is, however, inferior to the Stourge brick, the latter being used where intense heat is erated.

. *Tiles.*—There is a variety of other articles made he brick-yards of this locality, as, roofing tiles in ɜral varieties, tubular drain tiles from 3 in. to 16 in. er, and generally 18 in. long; also floor tiles or rries both red and blue, the latter resembling the brick.

. *Clay.*—The blue colour is obtained from the same that fires red by additional heat being generated n blue is required, at a cost of half a ton more coal, two hours more time allowed per oven. The clays narls are selected for the purposes to which they are adapted, and an extensive supply of the best quality red is procured at Cobshurst, about two miles south Longton (which marl is used to make the red orna-

mental and encaustic tiles, now so much admired, ar which are extensively made by Messrs. Minton and Co of Stoke-upon-Trent). Marls and clays suitable f brickmaking are plentiful, and of several varieties, in th neighbourhood, but the most extensive bed of red ma runs in an almost unbroken line through this count from south to north, and generally west of the gre coal-field, and is worked with the same results Stourbridge, Tipton, Hanford, Basford, Tunstall, a other places. A reference to a map of the count will show the peculiarity of this long bed of stratifi marls.

5. In the pottery district there are about ten disti sorts or strata. The following names are given to t seven sorts most used; and their position with relati to the earth's surface is shown by the order of th names here given.

Top red marl, dun coloured, top yellow (rotten r not used), mingled, bottom yellow, brown, and bott grey.

Seven of these marls vary but slightly in th chemical composition, and, when used, three sorts least are generally mixed together. (For an Analy of the above-named marls, see Table 1, art. 37.)

In this locality there is a very favourable combinat of circumstances for the manufacture of ornamen bricks for architectural decorations; and were arc tects to give the subject their attention, and s bricks free from duty, much might be done.

6. The following description of the process and c of brick and tile-making will apply, first, to the m of bricks, &c., upon the property of the manufactur and, secondly, to the make of tiles, &c., at a yard wl is rented.

FIRST EXAMPLE.—BRICKMAKING.

. *Buildings and Plant.*—This yard, with the ground
ned for work, has an area of about 6 aeres, and has
following buildings and maehinery upon it, viz.:—

A 5-horse power steam engine;
A set of horizontal rollers;
(Three pairs to the set, placed over each other).
A pug-mill;
Six drying-houses;
And nine ovens.

drying-houses measure 40 yards in length, by $8\frac{1}{2}$
ls in width, and have two flues under the floor
ugh their entire length.

t times they fire these nine ovens in one week;
if used exelusively for brieks, eaeh oven eould
red five times in a fortnight. Besides brieks, the
wing goods are made at this yard:—pipe tiles from
. to 16 in. diameter, roof and ridge tiles, quarries,
brieks, &e.

Rate of Production.—Provided the make were
ned to brieks, with these eonvenienees they would
e 100,000 weekly during the usual briek season,
h at the present selling priee, £1 8*s.* per 1,000,
a weekly produee value £140, whieh quantity
d pay in duty £27 11*s.* 3*d.*, the duty being 6*s.* $1\frac{1}{2}$*d.*
,000, with 10 per eent. off: this leaves for eost of
uction and profit £112 8*s.* 9*d.*

Tempering.—The marls used at this yard answer
e deseription previously given. Their average eon-
ion when mixed is 1 in 10; that is, a 10-in. mould
a 9-in. briek when fired, although some of the
ties used separately contraet 1 in 6. The marls
ug and wheeled two runs for 4*d.* to 7*d.* per eube
the priee depending upon the diffieulty of digging.
marl is then plaeed in a hopper over the topmost

rollers, and passing successively through the three pa is deposited on a floor about 8 ft. below the hop The marl is then wheeled away, and some three or m sorts mixed together with a proper quantity of wa by spade labour (for the quantity of water in the r when dug, see Analysis, Table 1, art. 37). The m marls, if wanted for tiles or dust bricks, are now pa through the pug-mill; but if required for ordi bricks, the ground marls are mixed with marls have been weathered but not ground. Lastly, the r is tempered by spade labour until the proper degre plasticity is obtained.

10. *Moulding.*—The bricks are moulded by wha called the slop-moulding process at the rate of 3 per day.* The price paid for tempering and moul is 4*s*. 6*d*. per 1,000. The process is as follows: temperer wheels the prepared marl in a barrow plank, and empties it upon the moulding table. moulder having sprinkled sand upon the moul board, and upon that part of the table where the is moulded, takes as much clay as will fill the mo and by a quick roll and a tap gives the clot an app mate form to the mould; he then lifts up this lun clay about 12 in. high, and with force throws it the mould, pressing it down with both hands to fi the cavities, and strikes off the surplus with a wo striker, which he throws into a small water-box in of him after each time of using.† An attendant who has previously dipped a mould in a water-tr by the side of the table, places it on the table read the moulder, and carrying away the moulded

* In the neighbourhood of Nottingham, where the bricks are not st but *planed*, the rate of production is only 2,000 per day.—Ed.

† See chap. iii., art. 47.

the mould, carefully empties it on its flat side on
e floor; these operations are repeated until the floor
filled, when the moulding-table is removed to a
cond floor.

11. *Drying.*—The floors are of different sizes; a con-
nient size is 25 yards in length by 6 yards in breadth,
on which they will lay 3,000 bricks. Here they are
owed to dry until sufficiently hard to handle and place
hacks, the length of time depending upon the weather.
quick drying weather they will remain half a day as
posited from the mould, and half a day turned upon
ge, and afterward they are placed up in hacks, where
ey remain until placed in the oven.

12. An ordinary blue brick weighs, wet from the
uld, 12 lbs. 4 oz.; when fired it weighs 8 lbs. 1 oz.,
ving lost by evaporation in drying and burning 4 lbs.
z., or 34 per cent. of its original weight.

The specific gravity of an ordinary blue brick
the wet state from the mould is . . . 2,171
In the dry state, ready for the kiln . . 2,075
And when burned, the specific gravity is . 1,861

The Table on the next page shows the amount of
poration during the process of drying.

The total loss of weight in drying and burning is as
lows :—

96 ounces, the weight of a brick wet from the mould.
16 ,, ,, lost by drying, or 23½ per cent.
—
50 ,, ,, dry ready for the kiln.
21 ,, ,, lost in burning, or 14 per cent.
—
29 ,, ,, of an ordinary blue brick.

13. *Burning.*—The oven is of a circular form, with a

1848.	Times of Weighing.	Loss of weight in ounces.	Interval in hours between each weighing.	Loss of Weight in ounces in each 12 hours, the day and night.
August 3rd	at 7 A.M., weighed oz. 196			
" "	11 " " 191½	4½	4	
" "	3 P.M., " 173¼	18¼	4	27½ in the day time, 12 hours.
" "	7 " " 169	4¼	4	
" 4th	7 A.M., " 163½	5½	12	5½ in the night, 12 hours.
" "	11 " " 157¾	5¾	4	
" "	3 P.M., " 153½	4¼	4	10¾ in the day, 12 hours.
" "	7 " " 152¼	1¼	4	
" 5th	7 A.M., " 150	2¼	12	2¼ in the night, 12 hours.
		46		

The loss of weight is 46 ounces by evaporation in drying, previous to being placed in the kiln to be fired or burned, or 23½ per cent. of its original weight.

spherical top, and will contain 8,000 bricks, which a so placed as to allow a space between the sides of ea for the action of heat, and an equal diffusion there When the oven is full, the clammins or doorway is ma up, and the fires kindlcd and kept burning 36 hours f rcd, and 38 hours for blue bricks, consuming 3½ tons coals for the formcr, and 4 tons for the latter. T

pense of setting, firing, and drawing an oven of
)00 bricks is as follows: labour 12s., and coals
. 13*s*. 4*d*.

14. *Cost of Manufacture.*—The details of the cost of
ınufacture are as follows :—

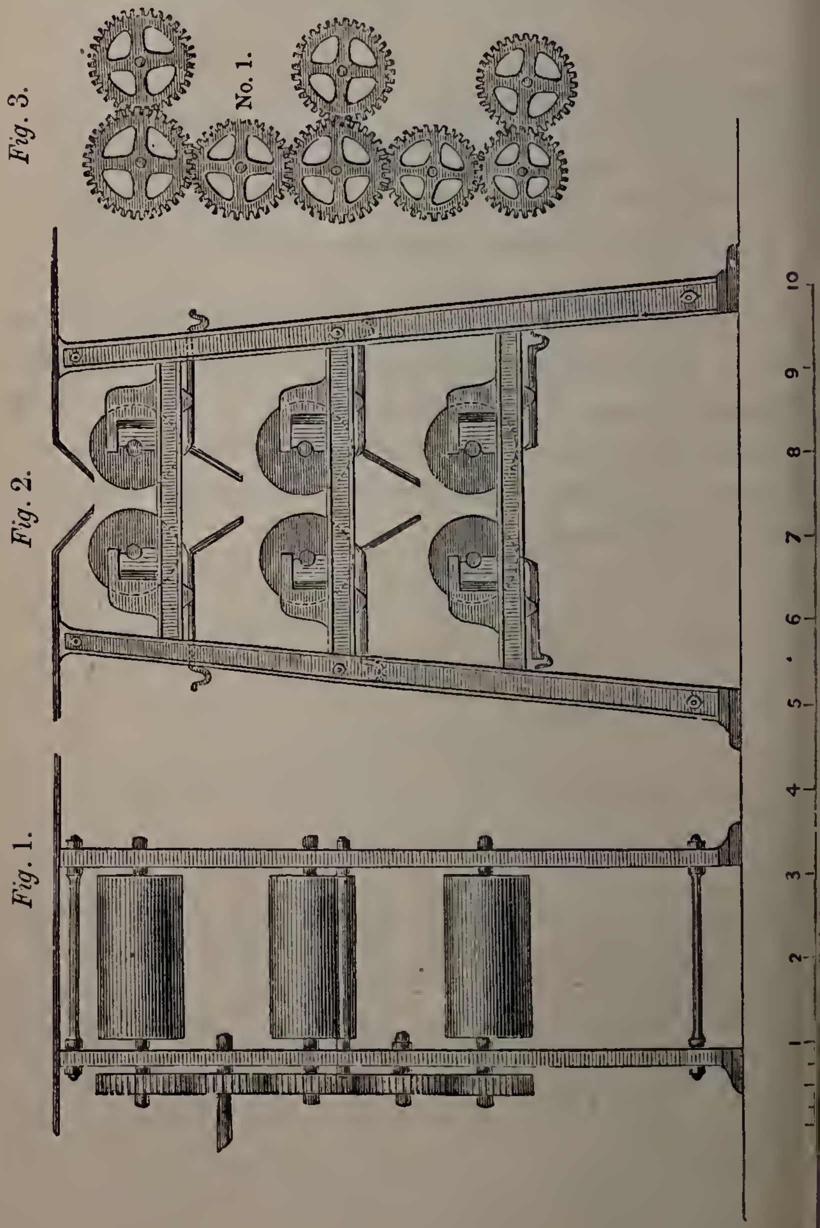
		£	s.	d.
Clay getting	per 1,000	0	1	6
Tempering and moulding	,,	0	4	9
Setting oven, firing and drawing . .	,,	0	1	6
Coals, 4 tons at 8*s*. 4*d*., divided amongst 8,000	,,	0	4	2
Duty, 5*s*. 10*d*., with 5 per cent. added .	,,	0	6	1½
Rent, machinery, clay, contingencies, and profit	,,	0	9	11½
Present selling price for ordinary blue bricks	,,	1	8	0

15. *Rental.*—Brick-yards with mines of marls are set
th the following appendages, viz. : 1 oven, moulding
drying-house, and pug-mill, with a breadth of brick
or and marl bank sufficient to work one oven for £30
r annum; if two ovens are worked in the take, they
e set at £25 each.

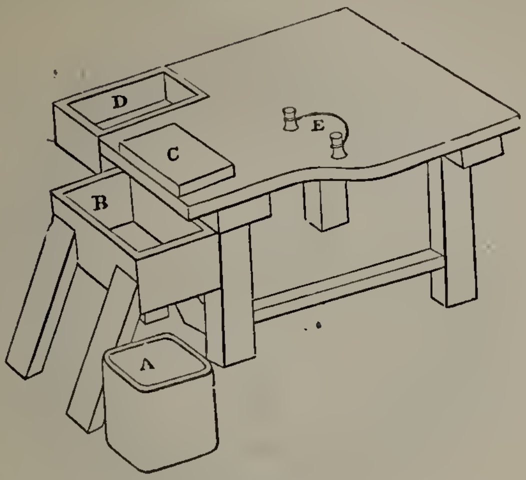
DESCRIPTION OF ILLUSTRATIONS.

16. *Figs.* 1, 2, 3, *Machine, with three pairs of Roller[s] for grinding Marl.*

Fig. 1. Side elevation.
Fig. 2. Front elevation, with the gearing removed.
Fig. 3. Elevation of gearing, No. 1 being the driving wheel.



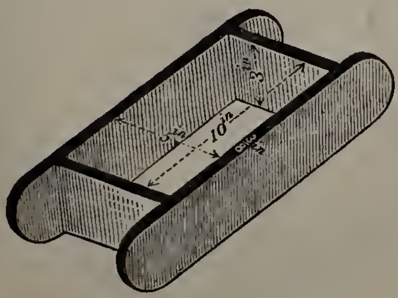
.7. *Fig*. 4. *Isometrical View of a Moulding Table.*



. Sand basket. B. Detached water-box. C. Moulding board
D. Water-box. E. Clay knife.

n the process of moulding the moulder takes in his hand, from the ‹et, a portion of sand, and dusts upon that part of the table where he s the clay into the form necessary to mould; also upon the moulding rd. The water-box or trough, B, is used by the boy to wash the mould ınd is lower than the table, so as to be convenient for that purpose. : water-box, D, is level with the table, and is used to throw the strike .fter each time of using.

18. *Fig*. 5. *Isometrical View of a Brick Mould.*



N B. The mould is made of oak, the edges plated with iron.

19. *Figs.* 6, 7, 8, *and* 9. *The Oven or Cupola*

Fig. 6. Plan taken at top of fire-holes at level A B, *Fig.* 9.

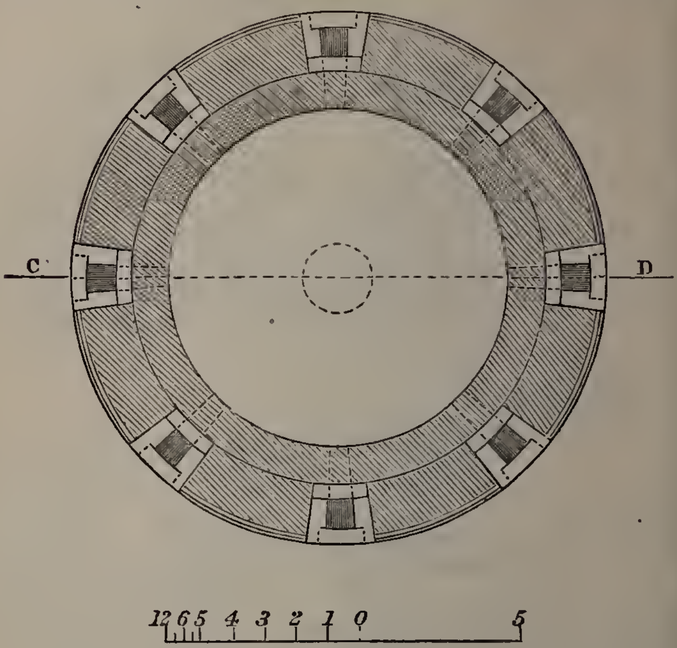


Fig. 7. Plan, looking down on top of oven.

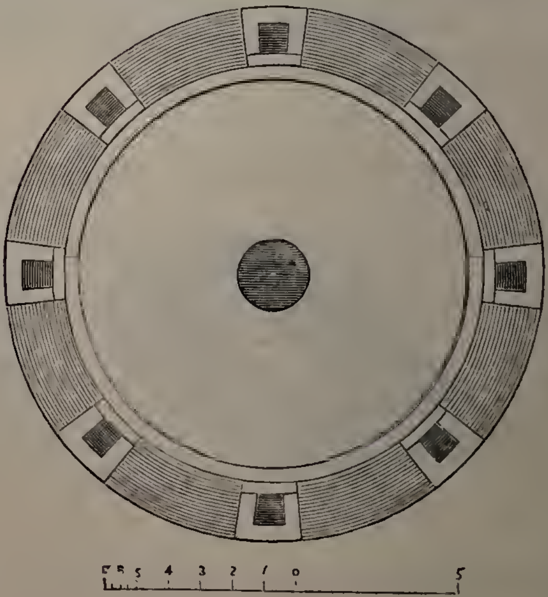


Fig. 8. Elevation.

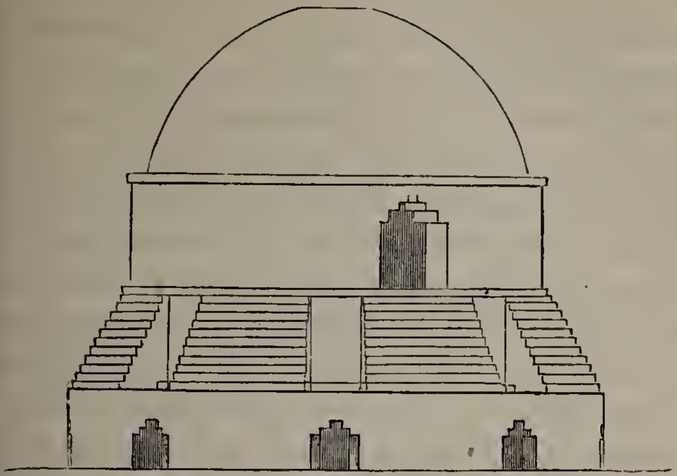
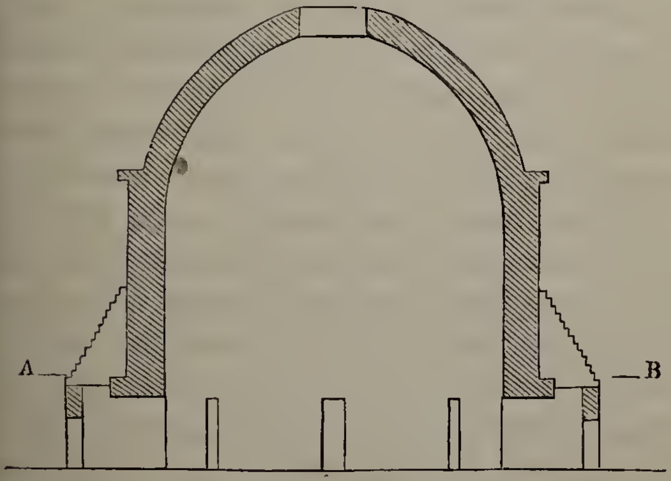


Fig. 9. Section, on line C D, *Fig.* 6.



SECOND EXAMPLE.—TILE MAKING.

20. At Basford there is an extensive hill of good marls
n which eight brick-yards are supplied (working four-
n ovens), some of which have been in work for forty
rs. The makers are subject to the rental stated in
15. The leading article made at these yards is roofing

tiles; besides which are also made some quarries, du bricks, drain tiles, and just so many common bricks as a necessary for the manufacture of tiles, it being necessa in order to set the oven properly, to burn 2,000 bric with every oven of roof tiles, as will be hereafter plained. The process of tile making here is as follows:

21. *Weathering and Tempering.*—The marl is d and spread upon slopes of this hill (which has a sout east aspect) to weather; the length of time deper upon the quality of the air: a hot dry summer's day w do good service, and three or four such days wou enable the makers to collect a thin surface in a wor able condition. Frosty weather, provided it be dry, preferred; wet, and alternations of wet and dry, reta the process of what is termed weathering. During hot dry season marl can be dug, weathered, and ma in one month, and this is frequently done. At the ya here referred to, the workers collect their marls, weathered, at the foot of these slopes, and mix th with a quantity of water. That to be used for tiles placed in the pug-mill, and about 1 cube yard per ho is ground by one horse; and that used for comm bricks is not ground, but simply mixed and tempered

The pug-mill consists of a wooden tub sligh tapered, the largest end being uppermost; it is circu and about 6 ft. high and 3 ft. diameter at the top largest end, in which a cast-iron spindle revolv carrying a series of flat steel arms, arranged so as form by rotation a spiral or worm-like motion upon t clay, which is thereby pressed from a larger to a l diameter of the tub in which the clay is confined, a ultimately comes oozing out of an aperture at t bottom: this operation kneads the clay, and more co pletely mixes it, giving it great cohesive power. Th

ay or prepared marl is now ready to make roof tiles, ıst bricks, quarries, &c., and is wheeled away to the ock kept under cover for that purpose. The tiles, and articles in the making of which coal-dust is used, e made in a building called by brickmakers the *hovel* drying house: but they prefer placing their tiles ıen first moulded in the open air, weather permitting. ıe moulding of roofing tiles varies from that of bricks fore described, principally in the clay being stiffer, d coal dust being thrown in the mould each time it filled.

22. *Moulding.*—The mould is 12 in. by $7\frac{3}{4}$ in. and n. thick, made of oak plated with iron. The moulder his bench takes up a lump of clay, and works it by nd into an oblong square, somewhat less than the uld, say 11 in. by 7 in. or thereabout; the mould is ced upon the bench, and fine coal-dust thrown into the man then takes up the lump of clay in the right ition for the mould, and throws it into it with con-erable force; then, with a brass wire strained upon a oden bow, cuts off the surplus clay level with the uld, removes the lump, and finishes moulding the y left in the mould by adding a little clay if it be ıted, and smooths it over with a wooden tool. By side upon the bench he has two thin boards about size of the moulded tile, their surfaces are dusted r with coal-dust; upon one of these he places the ılded tile, without the mould, the half circular pro-ions extending beyond the board; and so he repeats process of moulding at the rate of from 1,300 to 00 per day, adding more clay to his lump about every tiles moulded, and in quantity about as much as the tiles moulded.

3. *Drying.*—The attendant boy carries away two

tiles at each time to the floor ; he takes up one on th
board, and by the thick part of the hand presses up th
two projections at right angles with the face of the til
and then places board and tile on his head, and tak
up a second and operates upon this in like manner,
he walks to the floor, where he lays the two tile
carrying the boards back to the moulding bench ; an
so he repeats his operations.

The tiles remain on this floor, out of doors in fi
weather, about four hours ; they are then collected an
placed close together, the nib end changed alternate
to allow of their resting close and square ; in this sta
they are walled up in a dry but not hot situation, a
so remain for a day or two : this is said to tough
them.

24. *The Set.*—The next process is to give them
curved form, sometimes termed the set, which is do
on a three-legged stool, called a horse, the top of whi
is a little larger than the tile, and is curved one way
about a 10 feet radius. With the horse is used
wooden block, curved to correspond with the surface
the horse. These implements are used as follows :
tiles are taken as last placed and put on this horse ;
man lifts up the wooden block and gives them th
sharp blows with it ; they are then carried away a
placed in an ingeniously built wall to complete
drying process (the wall built with the tiles to be drie
after which they are carried to the oven, twelve at ea
time, in a peculiar manner, with the edges of the ti
against the breast of the carrier.

25. *Quarries and dust bricks* are moulded in l
manner from stiff clay, coal-dust being used to facilit
the articles leaving the mould.

26. *Drain Tiles.*—Pipe drain tiles are made as

ws: the clay is first moulded to the length, width, d thickness required, and then wrapped round a um, the edges closed together by hand, the drum or andril turned round, and the pipe tile shaped by the erator's hand, assisted in some cases by a wooden ol: this is the mode of making pipe tiles from 3 in. 16 in. in diameter, whether cylindrical, tapered, or g-shaped.

The usual length is 18 in., and the diameter from in. to 9 in. They are sold at 1*d*. per in. bore; that is, pipe 3 in. in diameter and 18 in. long, would cost at e yard 3*d*.; and a pipe 9 in. in diameter and 18 in. ng, 9*d*. This price applies to cylindrical pipes without ckets.

27. *Tile Machines.*—One of Ainslie's machines has een introduced into this neighbourhood, upon the state of the Duke of Sutherland, for making small ibular drain tiles, which makes two pipes 1½ in. in ameter at the same time. The prepared clay is forced rough two *dods* to form the tubes, which are cut into ngths by wires affixed to the machine, and when artially dry are rolled straight by hand upon a flat arface, and then set up in racks to finish the drying rocess.

28. *Firing.*—Firing the articles enumerated in the revious description requires much more care than ring bricks, and as roof tiles are the thinnest and equire most care, the largest sized pipe tiles excepted, e shall describe firing an oven of such tiles.

On the bottom of the oven are first placed 2,000 ricks, as shown in fig. 13, and upon these are placed ,000 tiles, forming a square, the spaces between the iles and the curved side of the oven being filled up ith bricks, as shown in fig. 14. The tiles are placed

edgewise, in parcels of twelve, changing their directio each parcel of twelve. The nibs on the tiles space then off from each other, and support them in the vertica position; from this description, and a reference to th illustrations, it will appear, that the goods placed in th oven are in each case so placed as to allow the diffusio of heat between them; and as the uniformity of heat i the desideratum in firing blue bricks and tiles, th circular oven is found to answer better than any othe at present in use.

It is necessary to have a wall round the outside o the oven, about 6 ft. high, and at a distance therefron to allow the fireman space to attend his fires conve niently; this wall is dry built generally with imperfec bricks, and its use is to avoid one fire being urged mor than another by the set of the wind, which duty i performs tolerably well.

The oven being set, the clammins (doorway) is mad up with bricks daubed over with street sweepings as a loam; then the fires are kindled, and are kept slowly burning for the first 5 hours, after which they are pro gressively increased for the next 33, making 38 hours for hard fired blue tiles or bricks; four tons of coa being consumed in the firing. The heat is determined by the sight of the fireman directed to the mouths and top outlet of the oven. When the heat is obtained, and before the fires burn hollow, the mouths are stopped up with ashes to prevent the currents of cold air passing through the oven, which is then suffered to cool gradually. An oven is usually fired once a week, but may be fired three times in a fortnight. After firing, twenty-four hours should be allowed for cooling before an oven is opened to take out the tiles.

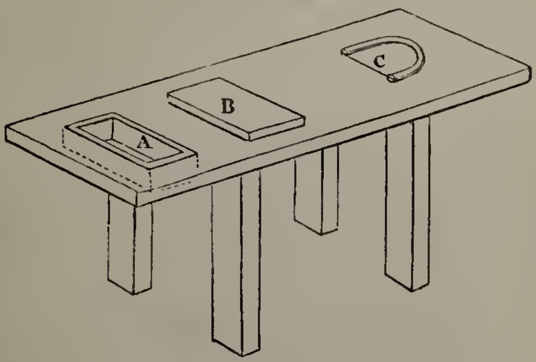
29. The following table shows the selling price per

000, and cost per superficial yard, of quarries, dust icks, and roof tiles :—

Size.	Price per 1,000.	Superficial measurement per 1,000.	Price per superficial yard in pence.	Thickness.	Description.
6 in. sq.	35*s*.	27·89 yards.	15·00	1 inch	Quarries.
7 „	46*s*.	37·80 „	14·59		
9 „	80*s*.	62·50 „	15·36	$1\frac{1}{4}$ „	„
9×$4\frac{1}{2}$	40*s*.	31·25 „	14·33	2 „	Dust bricks.
0 8×7 „	25*s*.	58·33 „	5·14	$\frac{1}{2}$ „	Roof tiles.

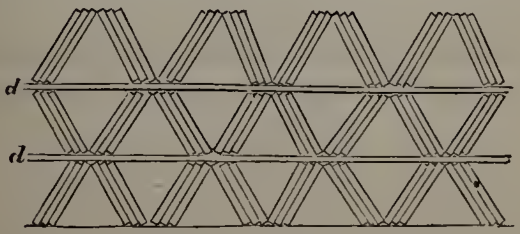
DESCRIPTION OF ILLUSTRATIONS.

30. *Fig*. 10. *Isometrical View of a Bench for moulding Tiles.*



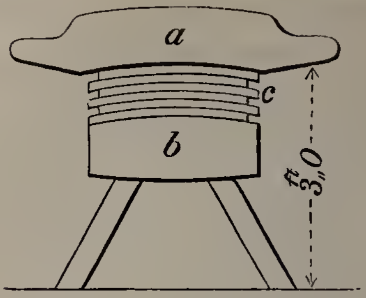
A. Coal-dust box, 14 in. by 8 in.
B. Moulding board, 14 in. by 10 in.
C. The bow.

31. *Fig*. 11. *Elevation, showing the Manner in which the Tiles are placed during the last Drying.*



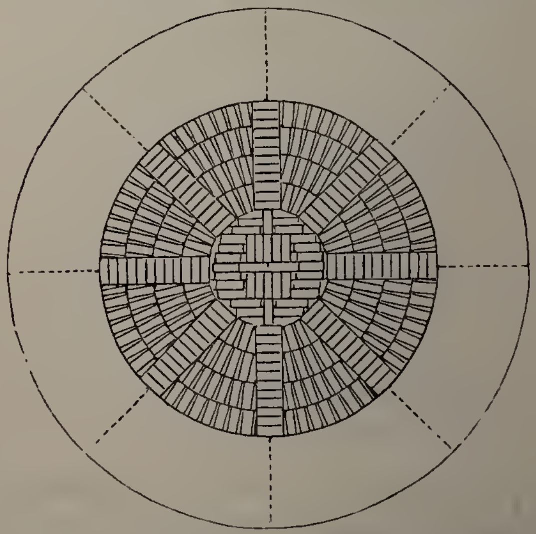
d d. laths, two to each course.

32. *Fig.* 12. *Tile Block and Horse.*



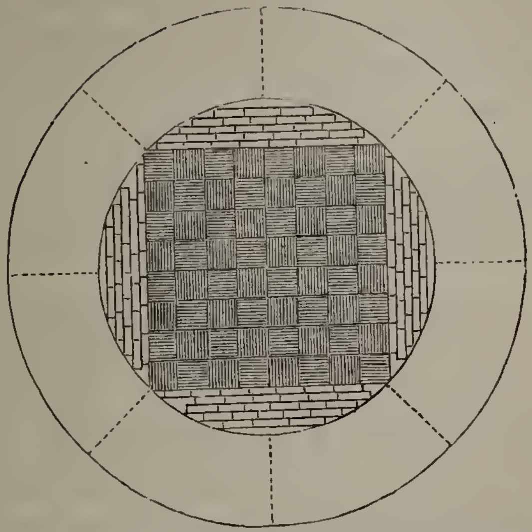
a. The block. *b.* The horse. *c* Tiles.

33. *Fig.* 13. *Plan of Oven, as seen when eight courses of Bricks are placed edgewise.*



The eight rows of twelve bricks in each, as seen in plan, cover a spa
left in continuation of flues from the eight fire-holes. The bricks in t
first seven courses are so placed as to leave a flue of an average width
4 inches. The dotted lines show the position of the fire-holes.

Fig. 14. *Plan of Oven, as seen when the first course of Tiles are placed upon the Bricks, as seen in Fig.* 13.



The tiles are placed in bungs of twelve, and laid alternately cross and ngthwise, the nib spaces them off, and supports them in a vertical sition. Each side of the square is made up with bricks, as shown on e plan.

35. The manufacture of bricks, &c., for building and aving purposes, in a systematic manner, in suitable remises with improved conveniences, so that the operaves may be employed the whole of the year instead of portion of it as now, is a subject deserving the attenon of the capitalist and inventor. Improvements in ie quality and conveniences of this manufacture are ntimately connected with the moral, intellectual, and hysical condition of society, as may be seen by a visit o any ordinary brickyard, and a reference to the vidence before the Sanitary Commission. Where exensive supplies of marls or clay are found, suitable orks might be erected for such manufacture, could a

cheap and ready mode of transportation be commanded so as to carry bricks, &c., a distance of 60 to 100 miles without materially increasing their price.

36. Assuming the weight of bricks to be 3½ tons per 1,000, the present railway charges for the carriage of bricks, viz. 2*d.* per ton per mile, if under 40 miles, and 1¾*d.* per mile if more than 40 miles, would add to their cost as follows:—

	£	s.	d.	
If carried under 40 miles . . .	0	0	7	per 1,000 per mile
Or for a distance of 39 miles . .	1	2	9	
And if carried above 40 miles . .	0	0	6	per 1,000 per mile
Or for a distance of 60 miles . .	1	10	7	

Therefore a carriage of 60 miles at the lowest railway rate more than doubles the value of a common brick compared with the price at the yard. The high rate of charge for carriage, and the duty, which amounts to nearly 22 per cent. of the selling price at the yard, constitute obstacles to the improvement of the brick manufacture, and the bettering of the condition of the operatives employed therein. The recent improvements in connection with domestic comfort and health, and the encouragement offered to architectural improvements in the houses for artisans, may probably awaken an interest in this department of industry, and place even brickmaking in the position its importance deserves, if not demands.

37. ANALYSES OF CLAYS, ETC.

TABLE 1.—Analysis of Clays, Nos. 1, 2, 3, 4, 5 and 6, from Basford ; 7 and 8 from the Staffordshire Potteries. By F. C. Wrightson, Esq., Birmingham.

	Red marl, which burns blue.	Dun coloured marl, burns good blue.	Top yellow marl, burns reddish blue.	Mingled marl, burns blue reddish.	Rotten red marl, will not stand the heat; it melts.	Mixture of clays, Nos. 1, 2, 3, and 4, burns good blue.	Clay from Stoke-upon-Trent, burns red, and will not burn blue.	Sagger marl, burns light buff—a fire-brick.
Number of Analysis	1	2	3	4	5	6	7	8
Silicic acid	69 87	64·32	65·78	70·17	42·84	59·44	60·02	54.38
Alumina	16·79	20·33	15 16	16·25	17·61	25·93	24·26	26·55
Peroxide of iron, with a little protoxide	8·88	10·86	8·49	8.41	6·97	10·74	9·14	—
Protoxide of iron, with a little peroxide	—	—	—	—	—	—	—	8·38
Lime	Trace.	Trace.	1·67	1·29	15·36	—	1·60	—
Carbonic acid	—	—	—	—	11.61	—	—	3·14
Oxide of manganese	—	—	—	—	2·20	Trace.	Trace.	—
Soda and a little potash	—	—	—	—	—	—	1·40	—
Water	4·26	6·60	5·37	5·86	3·94	3·11	3·89	7·28
	99·80	102·11	96·47	101·98	100.53	99.22	100·31	99·73

TABLE 2.—The Clays in Table 1 arranged in the order of infusibility, beginning with the most easily fusible clay, and calling that No. 1.

No.	1	2	3	4	5	6	7	8
Silicic acid	42·84	54·38	59·44	60·11	64·32	65·78	69·87	70·17
Number of Analysis in Table 1	5	8	6	7	2	3	1	4

TABLE 3.—The Clays in Table 1 arranged in the order of intensity of colour, beginning with the lightest shade.

Number of Analysis in Table 1	8	5	4	3	1	7*	6	2
Peroxide of Iron	about 1·	6·97	8·41	8·49	8·88	9·14	10·74	10·86

* Will *not burn* blue, burns *red*.

TABLE 4.—Showing the different proportions of bases contained in the Clays in Table 1.

Number of Analysis in Table 1	5	7	6	8	2	3	4	1
Alumina and other bases equivalent	50·91	35·18	32·93	32·65	[illegible]	[illegible]	[illegible]	[illegible]

No. 5, Table 1, contains 42·84 per cent. silicic acid; s requires, theoretically, 47·60 of alumina, or its mical equivalent in other bases, to form a fusible npound; it therefore contains only 3·31 per cent. ess of base. This is insufficient to prevent its fusion much larger excess would. No. 1 contains 22·59 base, which requires 25·1 of silicic acid, therefore 87 − 25·10 = 44·77 the excess of silicic acid, or *ombined* silica in the clay, rendering it infusible.

Analysis of Coal, called Norton Coal, used in the teries for burning pottery and bricks:—

Carbon	81·08
Hydrogen	5·04
Oxygen	10·55
Sulphur	0·36
Nitrogen	Trace.
Ash	2·97
	100·00

Analysis of a porous substance which floats in water. is a piece of a vitrified fort from Connel Ferry, near nstaffnage Castle, Scotland:—

lumina and peroxide of iron	28·45	This specimen has the appearance of pumice-stone. It is only very slightly fusible even in the very highest temperature of the blow-pipe.
ilica	67·85	
ime	0·32	
anganese	Trace.	
ater	1·88	
	98·50	

ICKMAKING ON THE SOUTH STAFFORDSHIRE RAILWAY.

8. The following additional particulars respecting ckmaking in Staffordshire were sent to the author this volume by Mr. J. L. Brown, of Farewell, near hfield, and are given in his own words:—

"The brickyard I visited is on the highway fr Lichfield to Walsall, at a place called Walsall Woo it is worked by Mr. George Brown, of the Sand Hil near that place. Mr. B. has another brickyard in t neighbourhood, more extensive than the one I visit and from these brickyards have been supplied all t bricks used for building the bridges, viaducts, catt arches, culverts, &c., &c., on the South Staffordsh Junction Railway.

"The brickyard I visited has six kilns or cupolas, a three large moulding and drying-sheds for use in t winter season, each 40 yards long by 8 yards wi having fire-places at one end, and traversed by flu longitudinally, to a chimney at the other end.

"The material used is not a clay, but a friable k of marl. The first stratum under the surface soil about 4 ft. thick, very compact in body, and requi the pick to get it; it is of a purplish hue. This is s ceeded by a stratum, 3 ft. thick, of bright yellow-look marl, equally intermixed with marl, of a bright sca colour, and afterwards, down to the depth of 20 ft., purple-coloured marl comes in again.

"The earth in its raw state is drawn up an incli plane on a common railway truck, by a steam-eng of 20-horse power, and at the top of the incline it t itself into a hopper placed over the cast-iron roll between which the marl passes and comes down inclined board, after being ground quite small. I afterwards wheeled into heaps and tempered, and then wheeled up an inclined plane of earth to the engi house, where it is passed through vertical cylinder cast iron, in the centres of which are revolving pist armed with flanges, like the screw propeller of a ste vessel, which grind the tempered clay and force

ough holes in the bottoms of the cylinders to mbers beneath them, whence it is wheeled to the ilders.

They make red and blue bricks of the same marl, pared in each case by rolling and grinding. To ke the blue bricks, they keep the fires very much rper and hotter, which changes their colour, and ms to run or fuse the material more, giving them at same time a shining appearance. They make very red bricks.

'The price of the best bricks at the kiln is 30*s*. per 00; common bricks, 25*s*. per 1,000. Plain-tiles roofing, 28*s*. to 32*s*. per 1,000. They also make mney-pots, pipes for the conveyance of water, splayed cks, coping bricks, and bricks to any model."

CHAPTER V.

BRICKMAKING IN THE VICINITY OF LONDON.

For facility of reference, we propose to divide the bject under three heads, as follows :—

1st. Materials and Plant.
2nd. Process of Manufacture.
3rd. Cost of Manufacture.

1. MATERIALS AND PLANT.

2. *Brick-earth.*—The brickmakers in the vicinity of ondon at present derive their principal supplies of ick-earth from the alluvial deposits lying above the ondon clay, the blue clay not being used for brick-aking at the present day. The general character of

the brick-earth may be described as being a grav loam, passing by fine gradations into either a str clay or into marl, or, as it is technically called, malm earth containing a considerable quantity of chalk in particles. We may, therefore, for the purpose of desc tion, class the several qualities of brick-earth under tl heads, as follows:* strong clay, loam, and malm.

3. 1st. *Strong Clay.*—This is generally sufficie free from stones to be used without washing, and bricks made from it are hard and sound, but are lia to crack and contract very considerably in drying, become warped and misshapen in burning. These fects are in a great measure removed by mixing earth with chalk, reduced to the consistency of cre as will be presently described, which greatly dimini the contraction of the clay, and improves the colou the brick.

4. 2nd. *Loam.*—The loams are often so full of gr that it is impossible to free them from stones, except passing the earth through the wash-mill. The quan of sand present in these earths renders them less lia to shrink and warp than the strong clays; but, on other hand, the texture of the earth is so loose and coherent, that a mixture of chalk is necessary to b the mass together, and to take up the excess of fus silica in the process of burning.

5. 3rd. *Malm.*—This is an earth suitable for mak bricks, without any addition, but there is very little r to be had, and for making the best qualities of bri (or, as they are called, malms) an artificial malm is ma

* It may be observed that this classification is such as would be understood by the generality of readers, but would not be comprehen by most brickmakers, who class these three qualities of brick-earth strong clay, mild clay, and malm. When the clays are strong, they said, in brickmakers' language, to be *foul.*

mixing together chalk and clay, previously reduced pulp in wash-mills. This pulp is run off into shallow s, where it remains until, by evaporation and settlement, it has become of sufficient consistency for subsequent operations. This process is adopted for the best alities of bricks only, as the expense of it is very conerable; and, for the commoner sorts, all that is done to mix with the loam or clay a sufficient quantity of lm to make it suitable for brickmaking: the quany of malm required for this purpose varies, of course, cording to the quality of the earth.

6. It will be readily understood, from the above narks, that the mode of preparing the clay differs eatly in different yards. The brick-earth (according its quality) being used—

1st. Without either washing or malming.

2nd. It may be malmed, *i.e.*, covered with artificial ılm.

3rd, and lastly. The bricks may be made entirely of ılm.

The second process is the most common, and we propose, therefore, in the following pages, to describe the ccessive operations of brickmaking as practised at ose works where the loamy character of the earth nders the malming indispensable. This will enable reader to understand the first and third methods of ating the brick-earth without any further description.

7. The object of adding chalk to the clay is twofold. the first place it acts mechanically, in diminishing contraction of the raw brick before burning; and the second place it acts chemically, as a flux during burning, combining with the silica of the clay, so it a well-burnt London brick may be described as ilicate of lime and alumina, and, therefore, differs

greatly from an ordinary red kiln-burnt brick made pure clay, without lime or alkaline matter, the sil and alumina of the brick-earth being, in the latter ca merely in mechanical and not chemical combination.

8. *Soil.*—The process of malming is not the o peculiarity of London brickmaking. Instead of bricks being burnt in close kilns, as is the practice most country yards, "clamping" is universally resor to; and to render this effective, it is considered nec sary that the fuel should be mixed up with the bri earth, so that each brick forms, as it were, a fire b and becomes thoroughly *burnt* throughout, instead being merely *baked,* as is the case in kiln burning. T fuel used in clamp burning is domestic ashes, or, as th are technically called, *breeze.* The ashes are collec in large heaps, and sifted; the siftings, which are cal *soil,* being mixed with the brick-earth, and thoroug incorporated with it in the processes of soiling "tempering," whilst the cinders, or "breeze," are u as fuel. A small quantity of coal and wood is a made use of in lighting the clamp.

The soil, or sifted ashes, materially assists in p venting the contraction of the raw bricks whilst dryi and the sulphur contained therein appears to assist colouring the bricks when burnt.

9. *Sand.*—The moulding sand is brought, at a c siderable expense, from the bed of the river Than near Woolwich. It is spread out to dry in the sun thin layers, which are repeatedly raked over, so as expose every particle in succession to the sun's ra that the whole may be perfectly dry when brought the moulding stool. The moulding sand serves m useful purposes. It assists in preventing the contr tion of the clay, and gives a more durable surface to bricks. It is indispensable to the moulder for

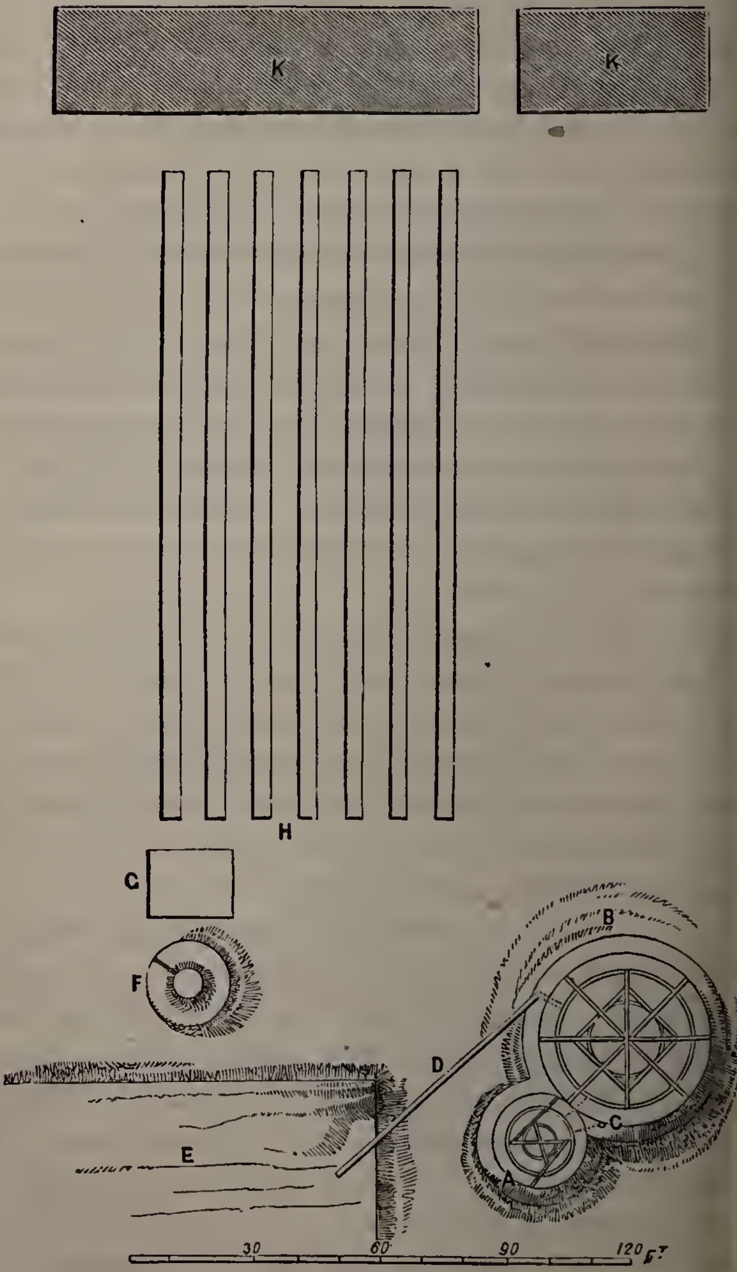
ting the bricks from sticking to his mould. It also vents the bricks from sticking together on the hacks, from breaking up into cracks and flaws when cool- after being burnt. Lastly, the salt in the river l becomes decomposed in the burning, and assists uxing the brick-carth, and in giving the bricks their colour. Common sand burns of a red tint, and ld injure the colour of the London bricks.

0. *General Arrangement of a Brickwork.*—This will eadily understood by reference to fig. 1. The brick- h is turned over to receive the malm as near as sible to the clay pits. The clay and chalk mills are ed close together in some convenient position, so o interfere with the works as little as can be helped, the malm is conveyed from them to the heap of k-earth, by means of troughs or shoots supported ressels.

lose to the brick-earth, and immediately behind the ilding stool is placed the pug-mill, and in front of moulding stool is the hack ground, which should, if sible, be laid out with a gentle fall towards the ps, which is placed at its furthest extremity. se arrangements are of course much modified by the umstances of the locality.

1. *The Chalk and Clay Mills.*—These washing- s are placed close together on a large double mound, ciently elevated to allow the malm to run down ly to the brick-earth. The chalk-mill is a circular gh lined with brickwork, in which the chalk is ind by the action of two heavy wheels with spiked s, made to revolve by either one or two horses. The gh is supplied with water by a pump, the lever of ch is worked by the machinery of the clay-mill, and he chalk becomes ground into pulp it passes, by

Fig. 1.



ans of a shoot, into the clay-mill. The clay-mill is o a circular trough, lined with brickwork, but much ger than that of the chalk-mill; and in this trough clay is mixed with the pulp from the chalk-mill, and cut and stirred by knives and harrows put in motion two horses, until the whole mass is reduced to the isistency of cream, when it passes off through a brass ating into the troughs or shoots, and is conducted to brick earth which has been heaped up to receive it. e machinery of the washing-mills is very fully de-eated in figs. 2 to 10, and is described in detail in s. 53 and 54.

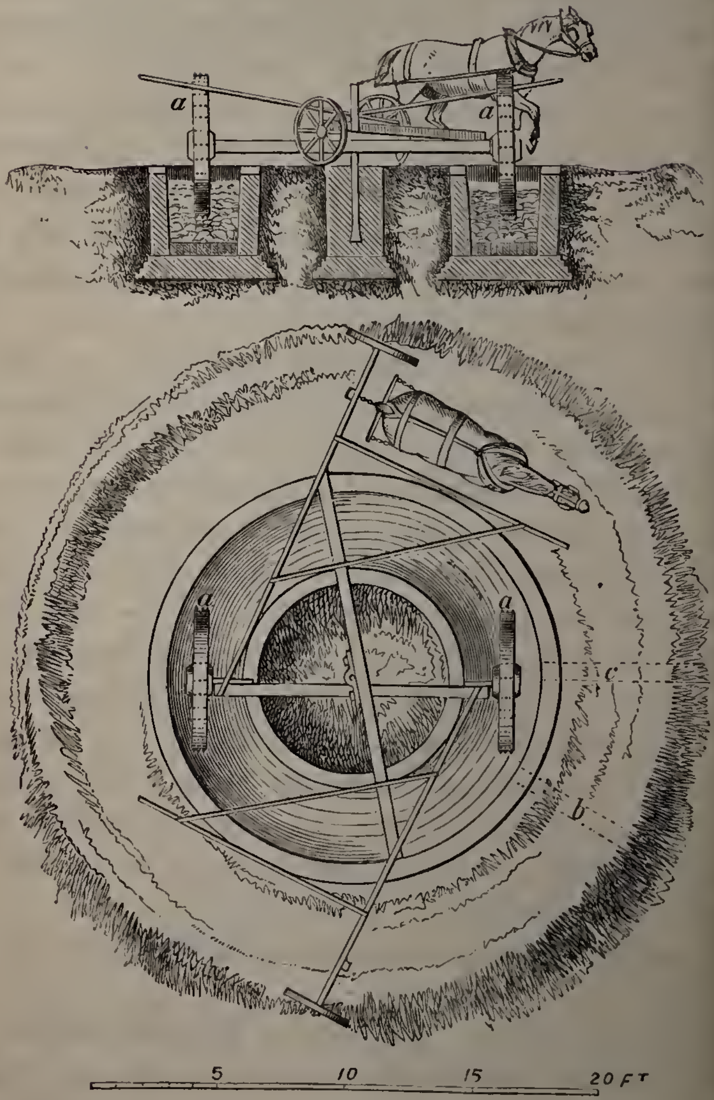
12. *The Pug-mill.*—The pug-mill used in brick-aking is a conical tub, with its larger end uppermost, the centre of which is a revolving vertical shaft of on, to which are attached horizontal knives, inclined that the clay is slowly forced downwards by their otion. The top and bottom knives are called *force ives,* and their use is merely to force the earth rough the mill, and out at the ejectment hole; all the her knives are furnished with cross knives, which sist in cutting the clay, and breaking up any hard mps that may not have been broken up by the previous ntering and turning over. In order to feed the mill, inclined barrow-run is laid up to it, to enable the heeler to tip the clay in at the top.

The construction of the pug-mill is shown in figs. 11 d 12.

13. *The Cuckhold,* fig. 13, is an instrument for itting off lumps of the tempered clay for the use of e moulder, as it is ejected from the pug-mill, and quires no particular description.

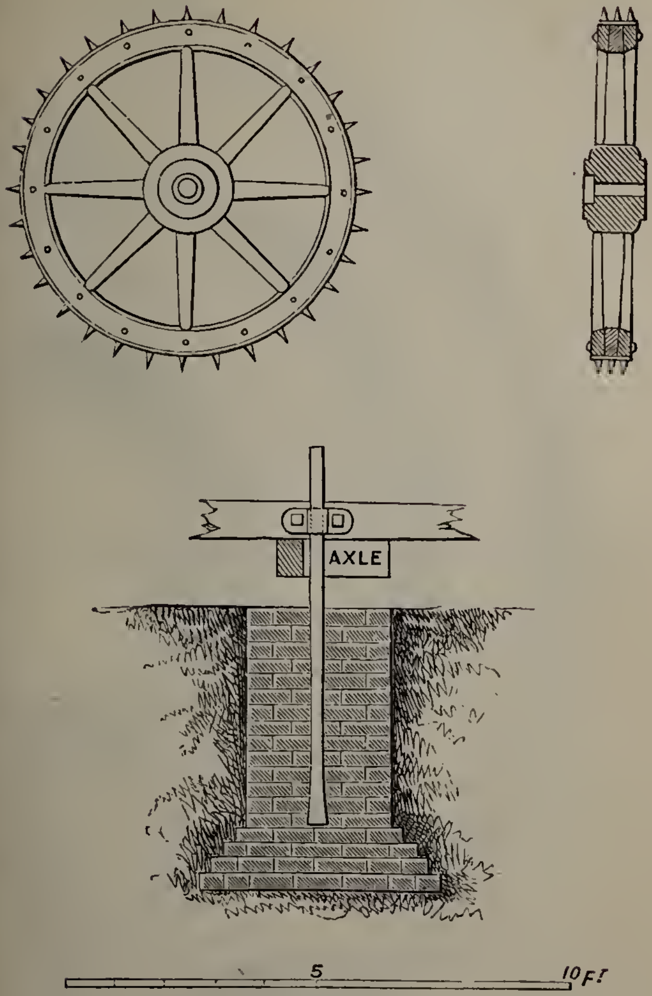
14. *The Moulding Stool.*—The moulding stool is ite different from that used in most parts of the

Figs. 2 and 3.



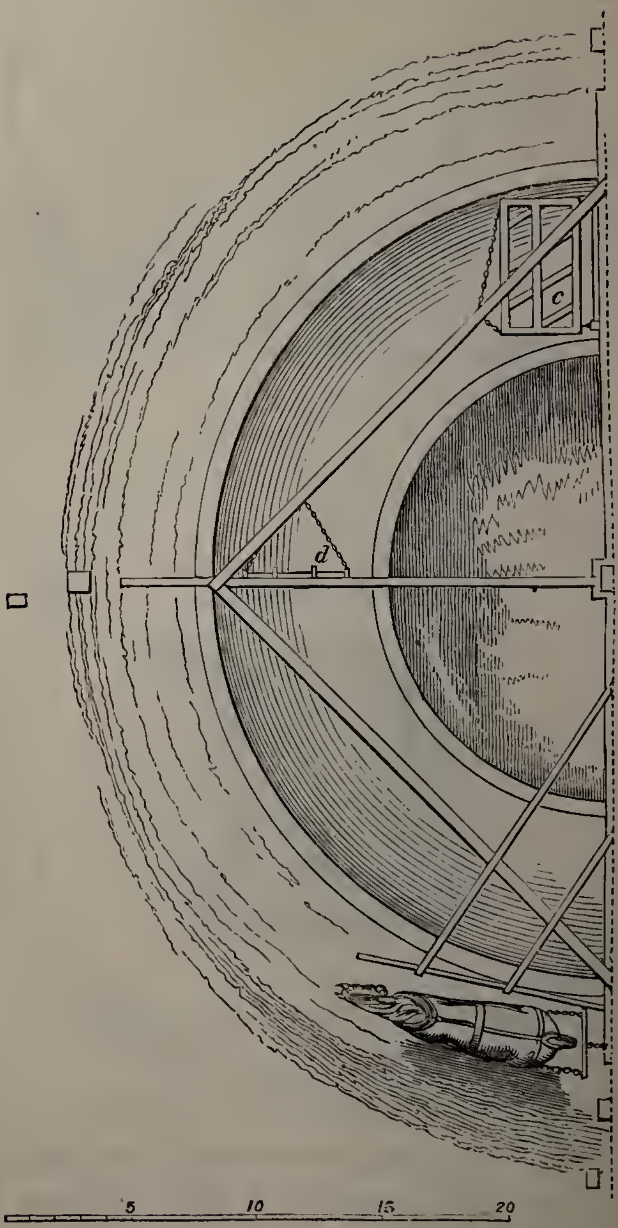
country. It has a rim at each end, to keep the mouldi[ng]
sand from falling off, and is provided with a *stock-boa[rd]*,
which forms the bottom of the brick mould, and wit[h]

Figs. 4 and 5.



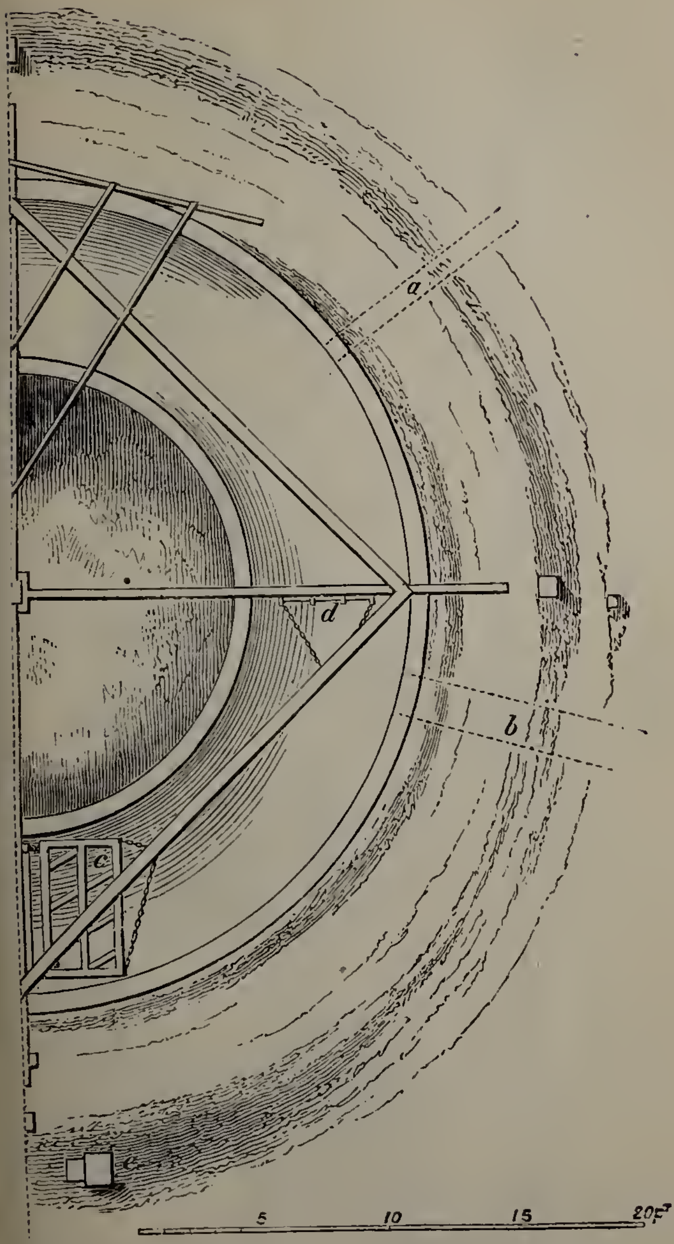
e, which is formed with two rods of $\frac{3}{8}$ iron, nailed wn at each end to the wooden rails on which they t. The use of the page is to slide the raw bricks re readily from the moulder to the place from whence y are taken and put upon the hack barrow by the aking-off" boy. The moulder, when at work, stands

Fig. 6.



near the middle of the stool, with the page on his
hand, and his assistant, the clot-moulder, on his rig

Fig. 6.



moulding sand for the use of the moulder and clot-
ulder is placed in separate heaps at the opposite ends

Fig. 7.

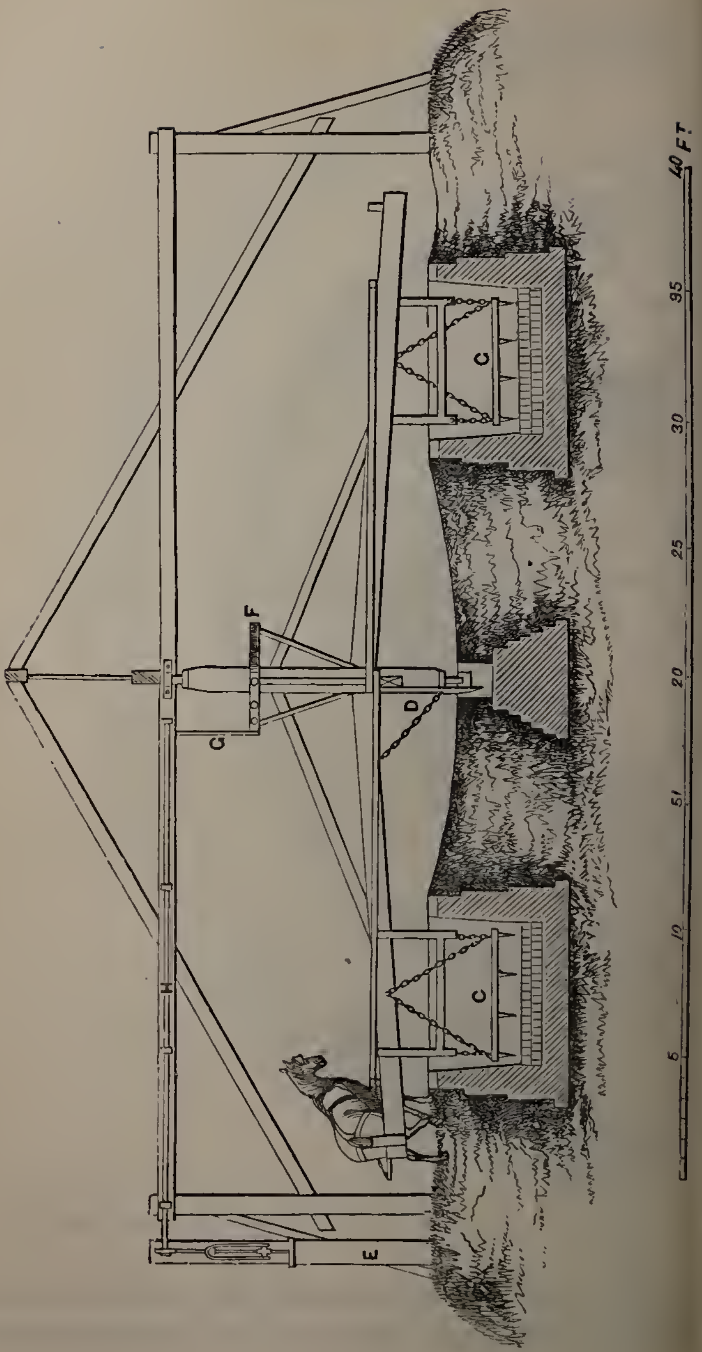
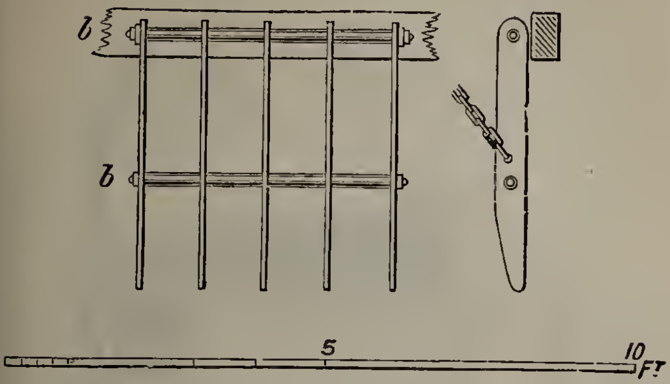
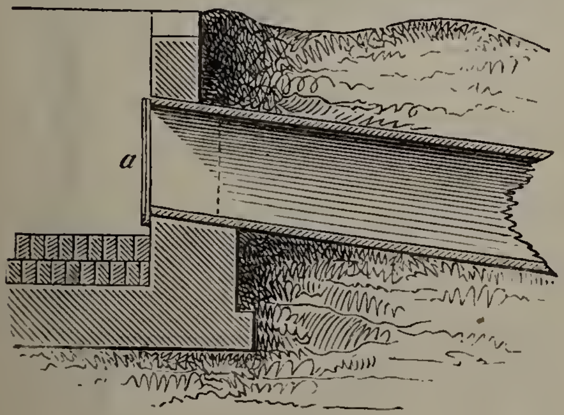
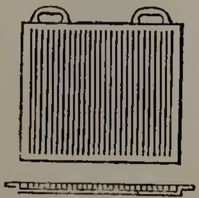


Fig. 8.



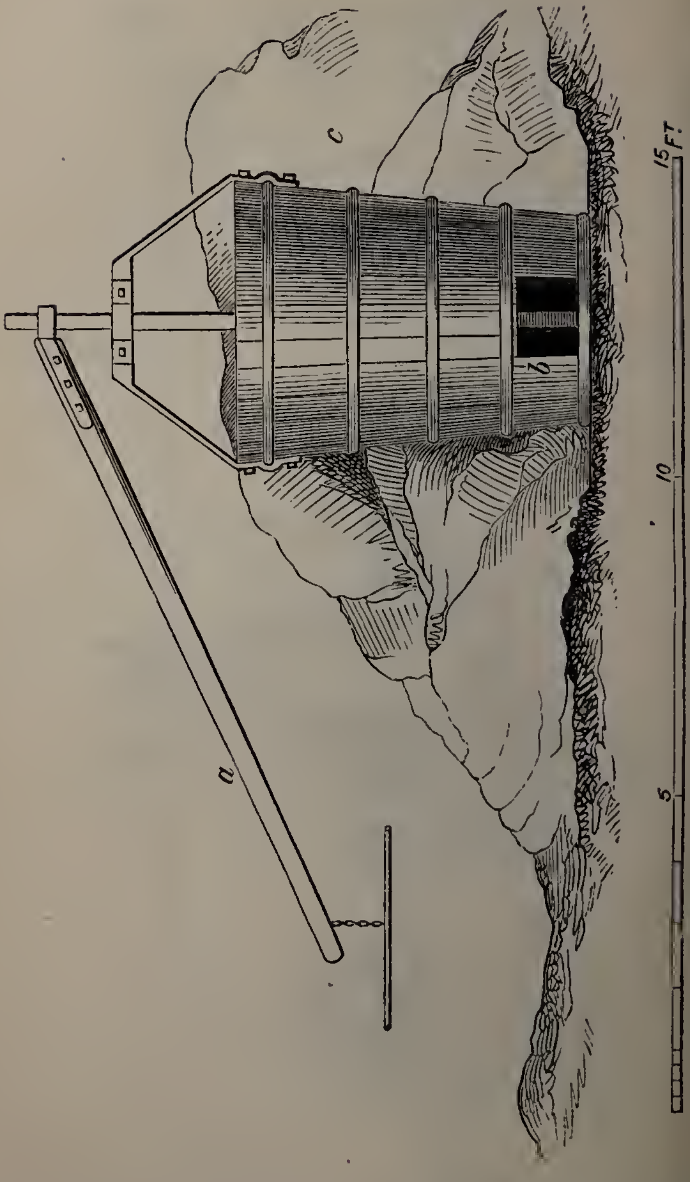
Figs. 9 and 10.





ıe stool, and the tempered clay nearly opposite to
moulder. There is no water-box, but a tub is placed

Fig. 11.



on the stool, into which the strike is thrown when
in use. The pallets are placed at one end of the pa

Fig. 12.

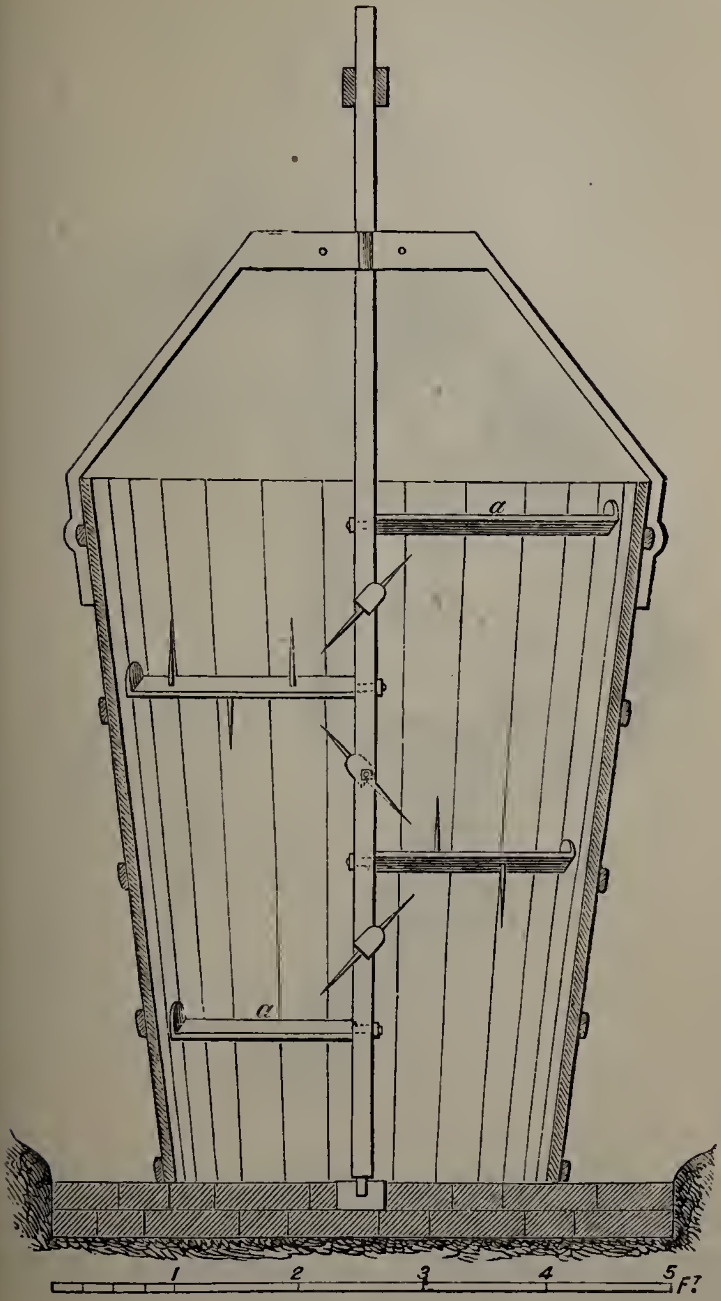
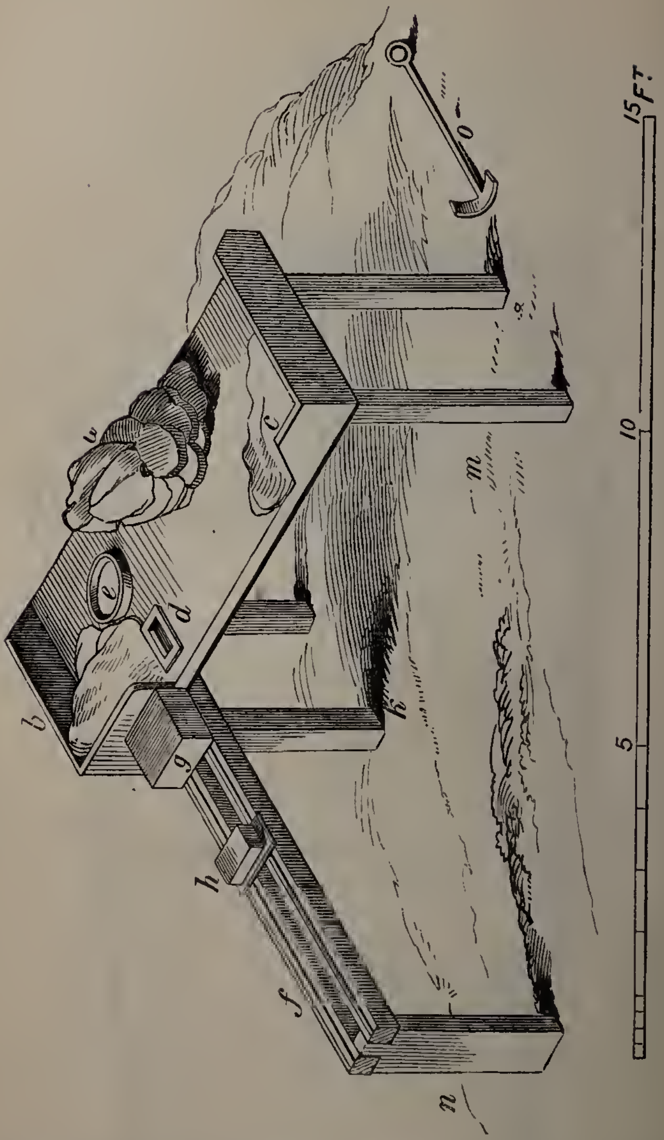


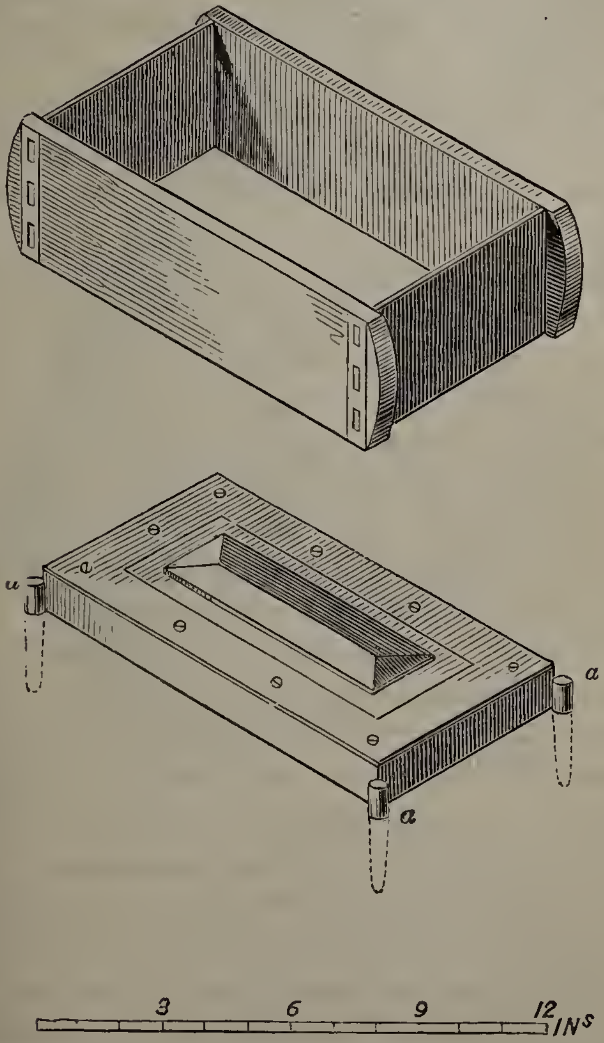
Fig. 13.



and close to the moulder's left hand. These particulars will be fully understood by reference to fig. 13, and to the detailed description in art. 56.

5. *The Brick Mould* is made of sheet iron, in four
ces, riveted together at the angles, and strengthened
h wood at the sides only. The bottom of the mould
letached, and forms what is called the *Stock-board*.
: fig. 14.

Fig. 14.



16. *The Stock-board* is a piece of wood plated with
n round the upper edge, and made to fit the mould

accurately, but easily. At each corner an iron pin is driven into the moulding stool, and on these pins the bottom of the mould rests, the thickness of the brick being regulated by the distance to which the pins are driven below the top of the stock-board. The hollow in the bed of the brick is produced by a rectangular piece of wood, called a *kick*, of the size and shape of the hollow required, which is fastened on the upper side of the stock-board.

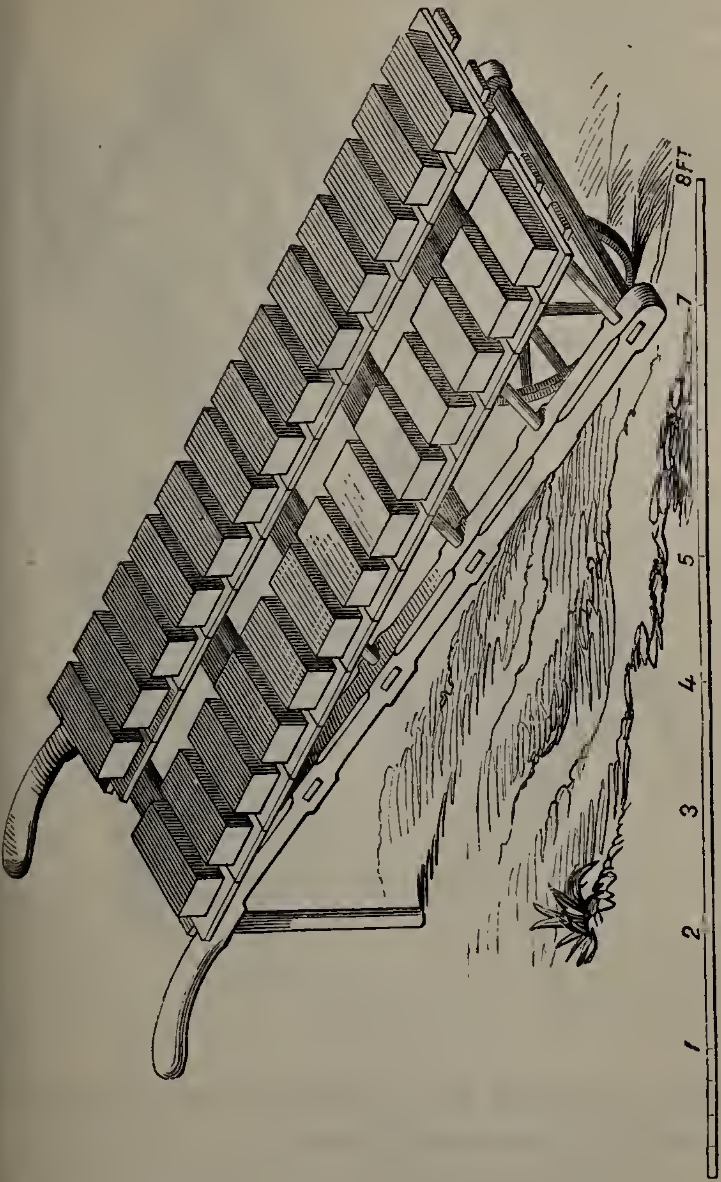
17. *The Strike* is a smooth piece of wood, about 10 in. long by 1½ in. wide and ½ in. thick, and is used to remove the superfluous clay in the process of moulding.

The Pallets are pieces of board ⅜ in. thick, and of the exact width of the mould, but about ¾ in. longer. Three sets of pallets, twenty-six in each set, are required for each moulder at work.

18. *The Hack Barrow*, figs. 15 and 16, is of a peculiar construction. It consists of a light frame, supporting a flat top of lattice work, on which the bricks are placed in two parallel rows, thirteen in each row. Three barrows are required for each moulder.

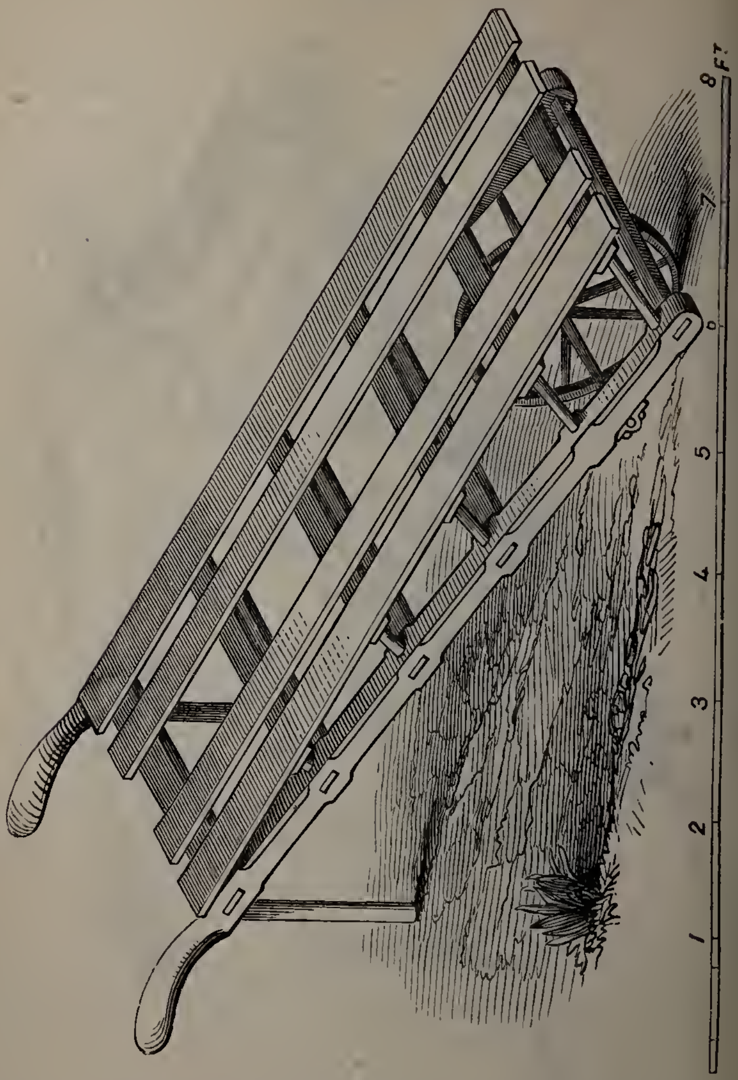
19. *The Hack Ground* occupies the space between the moulding stool and the clamp. It should be well drained, and it is desirable that it should be on a slight fall towards the clamp, as this lessens the labour of wheeling. The foundations of the hacks are slightly raised. It is of importance that the barrow-runs between the hacks should be perfectly even, as any jolting of the hack barrow would injure the shape of the raw bricks, which, when first turned out of the mould, are very soft. The hacks are placed 11 ft. apart, measured from centre to centre, their length varying according to the shape of the ground. It is very difficult to say

Fig. 15.



ıat extent of hack ground should be allotted to each
ɔulding stool, as this varies greatly in different yards.
round numbers, the quantity of land required for a
ickwork may be stated at from $1\frac{1}{2}$ to 2 acres for each

Fig. 16.



moulding stool, but this includes the whole of the la
required for the several purposes.

II.—PROCESS OF MANUFACTURE.

20. *Clay Digging.*—The first turning over of t
brick-earth should take place in the autumn, in orc
that it may have the benefit of the winter frosts befo

ng used. The vegetable mould and top soil having
n wheeled to spoil, the brick-earth is turned up three
four spits deep, and laid on a level floor, prepared for
purpose, and banked round to prevent the escape of
malm in the process of malming.

21. The quantity of clay required per 1,000 bricks is
iable, of strong clay more being required than of
lder qualities.

It is generally calculated that an acre 1 ft. deep, or
out 1,600 cubic yards of clay, will make 1,000,000
cks, but strong clays will require from 182 to 200
bic yards per 100,000 bricks. For practical purposes
quantity may be thus approximately stated:—

Strong clay 2 cubic yards per 1,000 bricks.
Mild clay $1\frac{3}{4}$ cubic yard per 1,000 bricks.

22. *Malming.*—It has been before explained that the
st bricks only are made entirely of malm, but that the
ocess of malming is resorted to for other descriptions
bricks, where the quality of the clay renders it unfit
brickmaking without this addition. It will, therefore,
readily understood that the quantity of malm mixed
th the clay in the ordinary process of brickmaking
ries very considerably, so that it is impossible to
y, *à priori*, what quantity of malm should be used, as
is must be left to the judgment of the brickmaker in
ch particular case, according to the quality of the
rth.

To keep the washing-mills in full work are required—

To the chalk-mill, 2 diggers and 1 wheeler.
To the clay-mill, 4 diggers and 2 wheelers.

The chalk-mill is worked sometimes with one, and
metimes with two horses. The clay-mill always re-
uires two horses. No drivers are required.

The average work of the washing-mills, working hours a day, may be taken at about 12 cubic yards malm,* or sufficient for making 6,000 malm bricks.

The process of malming scarcely requires descripti Water having been pumped into the troughs, chalk wheeled to the chalk-mill, and clay to the clay-m and the horses being driven round, the chalk is crus and ground by the wheels, and runs through the out into the clay-mill, where both chalk and clay get w mixed by the harrows, the liquid malm flowing through the brass grating to the shoots, by which i conducted to the brick-earth. As the heap becon covered the shoots are shifted, so that the malm sh be equally distributed over every part of the heap.

When a sufficient quantity of malm has been run it is left to settle for a month or more, until it become sufficiently consolidated to bear a man walki over it. As the solid portion of the malm settles, water is drained off from time to time, and when mass is sufficiently firm, the *soiling* is procee with.

23. *Soiling.*—The proportion of ashes depends v much on the quality of the earth, but may be stat approximately at about 35 chaldrons for every 100,0 bricks. The soil is laid on the top of the malmed ear the thickness of the layer depending on that of heap, about 3 in. of ashes being allowed for every s of earth.

The soiling concludes the preparation of the bri earth, which is allowed to remain undisturbed until

* At a manufactory of artificial hydraulic lime at Meudon, near Pa the chalk and clay are ground together in a washing-mill, of the s construction as those used in England, and worked by two horses. quantity of malm produced is about 1½ cubic yard per hour.—See V on Cements.

oulding season, which generally commences in April.
he first process of the actual manufacture is—

24. *Tempering.*—The heap, prepared as above, is ırned over by spade labour, and the ashes thoroughly corporated with it, water being added to bring the ass to a proper consistency. The tempered clay is ıen wheeled to the pug-mill, which, as before stated, is aced close to the clay heap, and immediately behind ıe moulding-stool.

25. *Pugging.*—The tempered clay being thrown in t the top of the mill, gradually passes through it, and ı so doing becomes so thoroughly kneaded as to be of uniform colour, the ashes being equally distributed ırough the mass. The quantity of clay ground is bout $1\frac{1}{4}$ cubic yard per hour, so that a horse working 0 hours per diem will grind $12\frac{1}{2}$ cubic yards of clay, r sufficient to make 6,250 bricks.

If the moulding process does not proceed as fast as he pugging, so that the clay will not be immediately sed, the clay, as it comes out at the bottom of the aill, is removed with the cuckhold, and covered with acks, to keep it from becoming too dry for use.

26. *Moulding.*—Before commencing moulding, the aoulding-stool is provided with two heaps of dry sand, tub of water, in which to place the strike, a stock-ıoard and brick-mould, and three sets of pallets. Everything being in readiness, and a supply of tem-ıered clay having been placed on the stool by the feeder, vhose business it is to carry the tempered clay from the ıug-mill to the moulding-stool, the *clot-moulder,* who s generally a woman, sprinkles the stool with dry sand, ınd taking a *clod,* or *clot,* from the heap of tempered ·lay, dexterously kneads and moulds it roughly into the shape of a brick, and passes it to the moulder on her

left hand. The moulder, having sprinkled sand on th stock-board, and dashed the mould into the sand-hea on his left hand, places the mould on the stock-boar and dashes the clot into it with force, pressing it wit his fingers, so as to force the clay into the angles the mould. He then, with the strike, which has bee well wetted in the water-tub, removes the superfluo clay, which he throws back to the clot-moulder to l remoulded. The mould is then lifted off the stock board, and placed by the moulder against one of th pallets, which he catches dexterously with his finger and, turning out the raw brick upon it, slides it alo the page to the taking-off boy, and, lifting up th empty mould, dashes it into the sand, and replaces on the stock-board, preparatory to moulding a seco brick; when he has moulded one set of bricks, l scrapes away the sand which has adhered to the mou during the operation with the strike, and then procee with the next set. A moulder and clot-moulder, wi the assistance of a feeder, a taking-off boy, and tw men to wheel and hack the bricks, will make abo 5,000 bricks between 6 A.M. and 6 P.M.; but th quantity is often exceeded.*

27. *Hacking.*—The raw brick is removed from th page by the taking-off boy and placed on the hac barrow, and when the latter is loaded, dry sand sprinkled over the bricks, and they are careful wheeled away to the hack ground. Having arrived that part of the ground where the hack is to be com menced, the man takes a spare pallet and places it o

* See the following:—"Brickmaking. On Wednesday last, Jos. Rus at Peterskye, Cumberland, performed the feat of making 1,000 bricks an hour; 100 in five minutes; and 26 in one minute."—*Carlisle Journ* (This is not a solitary instance.)

of the bricks, which he carries between the two ets to the ground, and sets it up carefully edgeways, ing care in removing the pallets not to injure the pe of the soft brick. One of the pallets is replaced the barrow, and with the other another brick is noved; and the process is repeated till the twenty-six cks have been placed on the ground, when the empty row is wheeled back to the moulding stool. In the antime another barrow has been loaded, and is ready wheeling to the hack ground. Three hack barrows required, so that one of them is constantly being oaded upon the hack ground, another loading at the ulding stool, and the third being wheeled to or from hack ground. Thus two men are necessarily em- yed in the operations of wheeling and hacking. The cks are set up two bricks in width, the bricks being ced slantwise, and not at right angles, to the length the hack. After the bottom row of one hack is com- ted, a second hack is commenced, to give the bricks e to harden before a second course is laid on them; l when the second course is commenced, the bricks st be placed fairly on each other, or they will be rked, which injures their appearance. The hacks carried up in this way until they are 8 bricks h, when they are left for a few days to harden. To tect the new bricks from frost, wet, or intense heat, aw or reeds are provided and laid alongside the hack, l with these the bricks are carefully covered up at ht, and at such other times as the weather may der necessary. When half dry, they are *scintled*,* at is, set farther apart, to allow the wind to pass ely between them, and they receive no further atten- n until sufficiently dry for burning. The time

* Literally, scattered.

required for drying varies from three to six wee
according to the weather.*

28. *Clamping.*—Figures 17, 18, 19, 20, and 21. T
process of clamping requires great skill, and its pr
tical details are little understood, except by the wo
men engaged in this part of the manufacture. Scarc
any two clamps are built exactly alike, the differen
in the methods employed arising from the greater sl
or carelessness of the workmen, and local circumstanc
such as the situation of the clamp, and the abunda
or scarcity of burnt bricks in the yard with which
form the foundation and the outside casing. We p
pose, therefore, first to describe the method of buildi
a clamp, according to the most approved system, a
then to explain the principal variations practised
different yards.

29. A clamp consists of a number of walls or *nec*
3 bricks thick, about 60 bricks long, and 24 to 30 bri
high, in an inclined position on each side of an *upri*
or double battering wall in the centre of the clamp, t
upright being of the same length and height as t
necks, but diminishing from 6 bricks thick at bott
to 3 bricks thick at top. The sides and top of t

* Mr. H. Chamberlain, in a paper read before the Society of Arts,
515, speaks of the great importance of drying bricks :—" The dryin
bricks ready for burning is a matter of great importance, and requ
more attention than it generally receives. From hand-made bricks
have to evaporate some 25 per cent. of water before it is safe to b
them. In a work requiring the make of 20,000 bricks per day, we h
to evaporate more than 20 tons of water every 24 hours. Hand-m
bricks lose in drying about one-fourth of their weight, and in drying
burning about one-third. The average of machine bricks—those m
of the stiff plastic clay—do not lose more than half the above amo
from evaporation, and are, therefore, of much greater specific gra
than hand-made ones." The artificial drying of bricks over flues can
course only be carried on where coal is cheap. Mr. Beart has contri
a steam chamber, where steam made to circulate in pipes is the sourc
heat for drying the bricks.

Fig. 17.

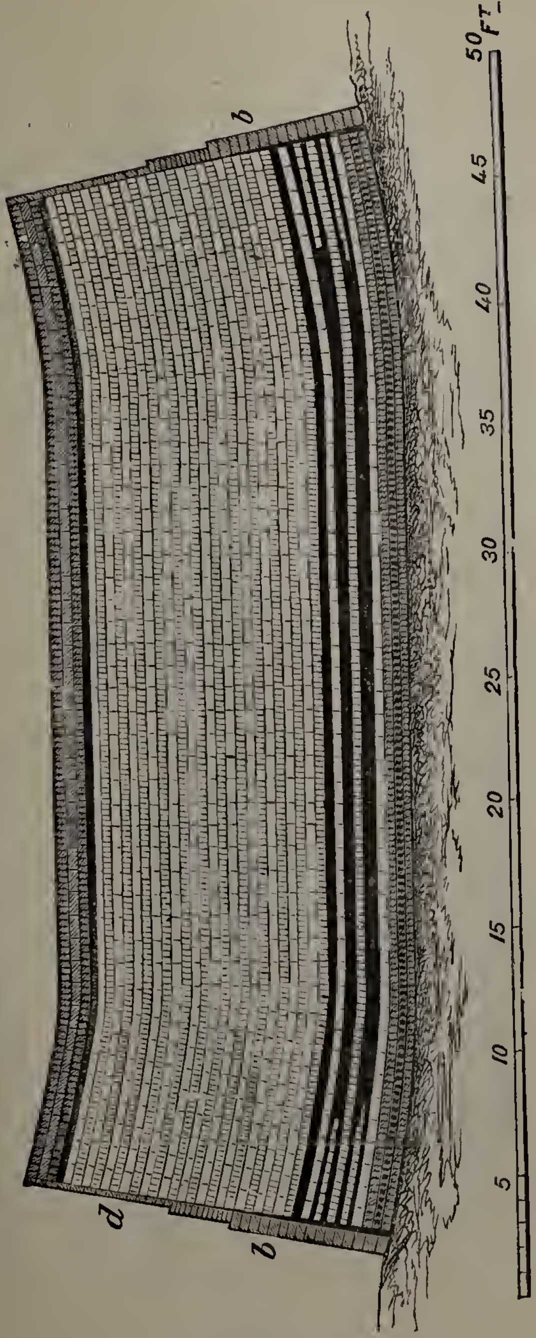


Fig. 18.

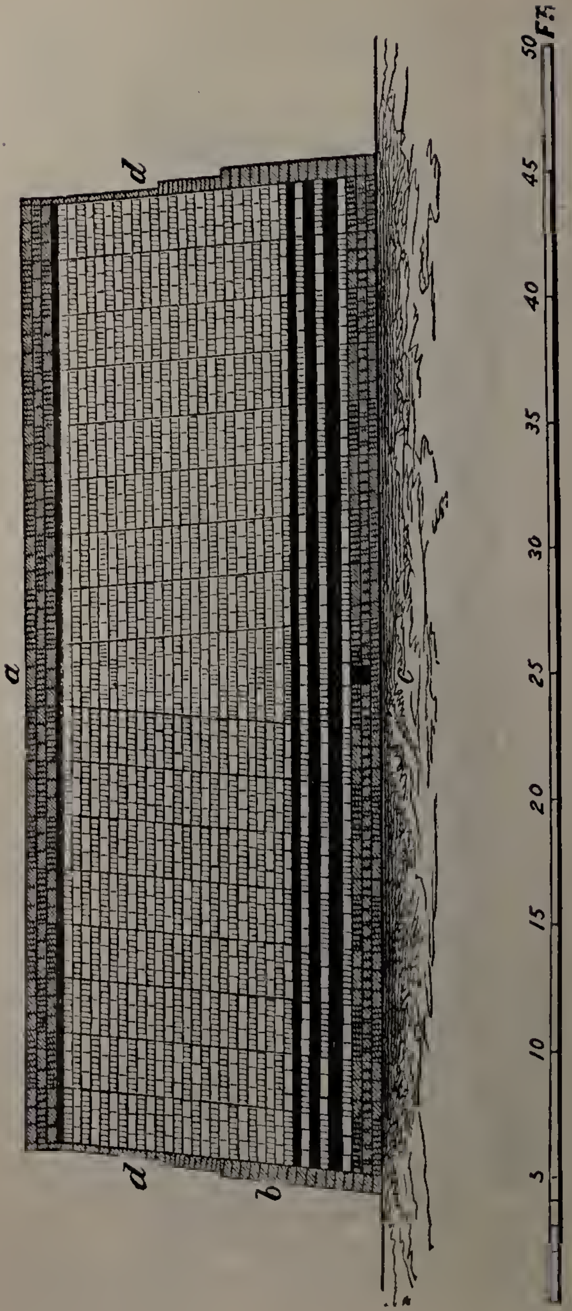


Fig. 20.

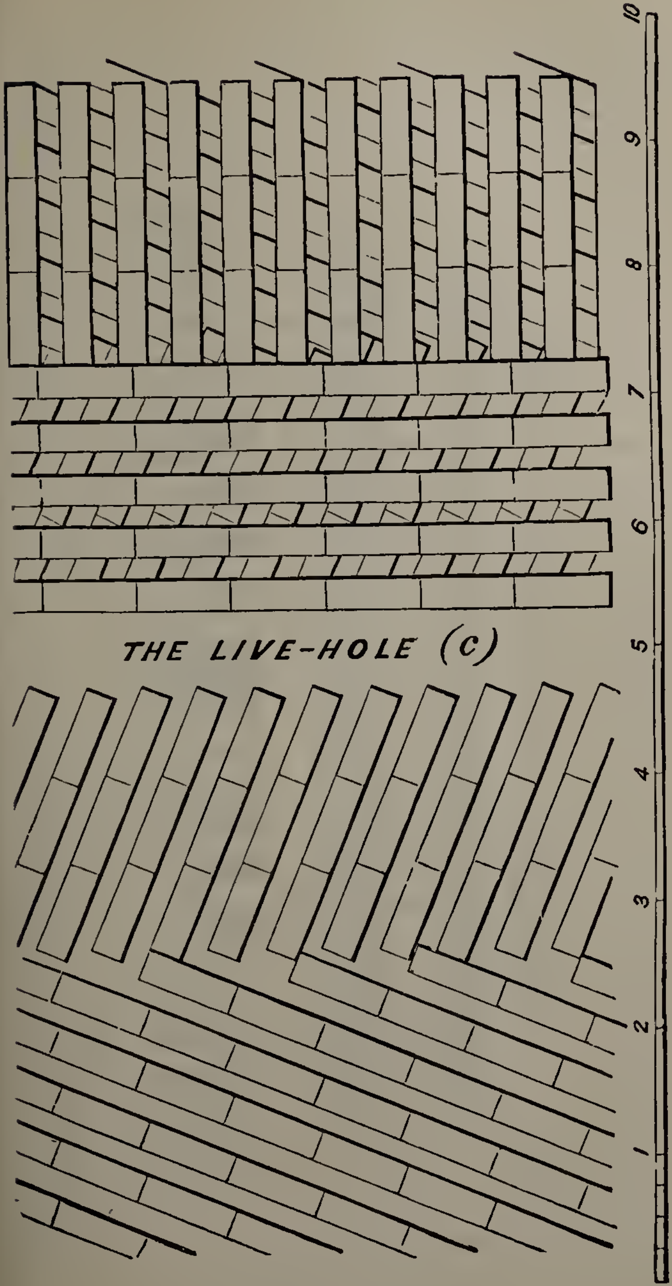
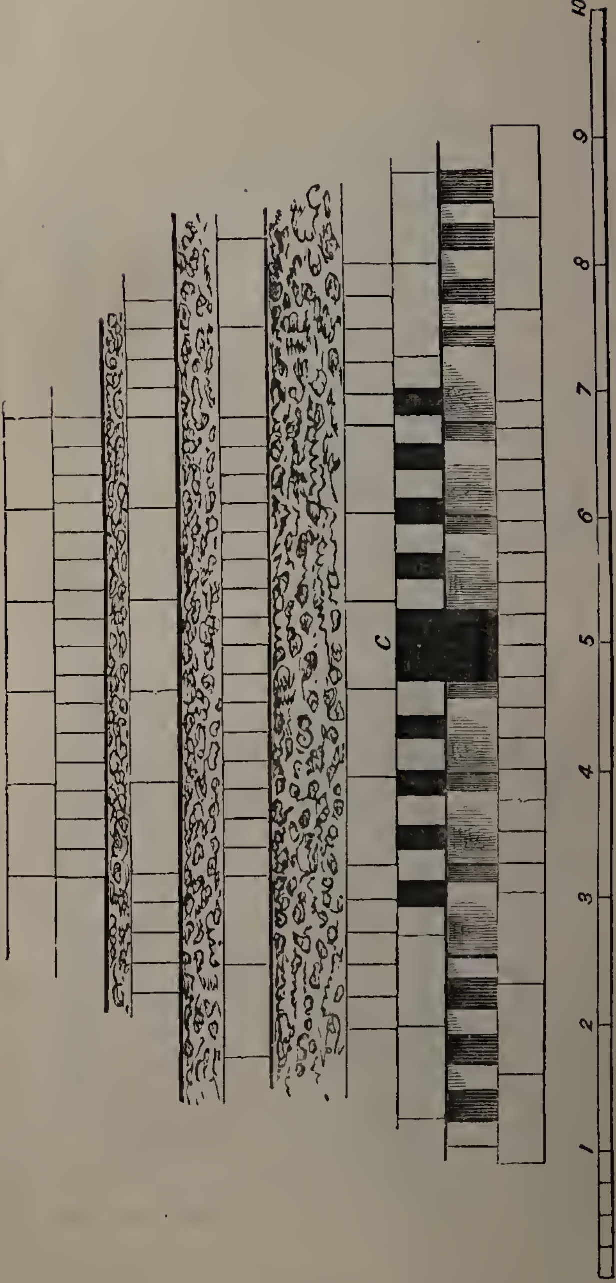


Fig. 19.

Fig. 21.



amp are cased with burnt brick. The fuel used in urning the laid bricks consists of cinders (breeze, as efore described), which are distributed in layers between ie courses of bricks, the strata of breeze being thickest t the bottom. To light the clamp, *live holes* or flues, in. wide and 9 in. high, are left in the centre of the pright, and at every 7th or neck. These live holes xtend through the whole thickness of the clamp, and re filled with faggots, which, being lighted from the utside, soon ignite the adjacent breeze. As soon as he clamp is fairly lighted, the mouths of the live holes re stopped, and the clamp burns until the whole of the reeze is consumed, which takes from three to six eeks. This description will give the reader a general dea of the arrangement of a clamp; and we will now escribe in detail the manner of building one, premising hat the term *close bolting* signifies stacking bricks so hat they shall be perfectly close to each other; and hat *scintling* means stacking bricks with spaces beween them.

30. *Foundation.*—The ground is first carefully drained nd levelled, and made perfectly firm and hard. The xact position of the clamp having been fixed, the round is formed with a flat invert whose chord is qual to the width of the intended clamp. The object f this is to give a *lift* to each side of the clamp, which revents the bricks from falling outwards as the breeze ecomes consumed. The ground being prepared, the pright is commenced. But, previous to building, the lamp barrow-roads or tramways of sheet-iron are laid lown between the hacks, and extended to the clamp round, to give an easy motion to the barrows; as, from the kind of barrows used in clamping, the bricks being piled on each other several courses high, and the

wheeling carried on with considerable velocity, they ar
apt to upset.

31. *Upright.*—The upright is commenced by building two 9 inch battering walls about 45 ft. apart, of burn bricks laid on edge, which are termed close bolts, th length of each wall being equal to the thickness of th upright, which at the bottom is 6 bricks thick, or abou 4 ft. 6 in. (their height is 16 courses, or about 6 ft.) Between these bolts a line is stretched, by which th upright is built true. The ground between the bolts i paved with burnt bricks laid on edge, to exclude th moisture of the ground. Upon this paving are lai two courses of burnt bricks with spaces between them termed scintles. In the bottom course of *scintles* th bricks are laid diagonally about 2 in. apart. Th second course consists of burnt bricks on edge, lai across the lower one, in lines parallel to the ends of th clamp, and also 2 in. apart. In laying these two course of scintles, a live hole is left about 7 in. wide, the whol length of the upright; and, on the completion of th second course, the live hole is filled up with faggots, an the whole surface covered over with breeze, which i swept or scraped into the spaces left between the brick On this surface is placed the first course of raw brick laid on edge and quite close, beginning over the live hole. Over this first course of raw bricks is laid stratum of breeze 7 in. thick, the depth being increase at the ends of the uprights, to 9 or 10 inches, by insertin three or four bricks on edge among the breeze. Th object of this is to give an extra lift to the ends. Th first course of bricks, it should be observed, is laid *a headers*. Over the first layer of breeze is laid a secon course of raw bricks on edge, *all stretchers*. This i covered with 4 in. of breeze, and at each end are inserte

'o or thrce bricks to incrcase the lift still more; but this
ne they are laid flat, not edgeways. Upon the 4 in.
yer of brceze is laid a heading eourse of raw brieks laid
ose, and on this 2 in. of breezc, without any extra lift at
e end. To this suceeed stretehing and hcading eourses
raw bricks on edge, laid close up to the top of the
amp, a layer of breeze, not morc than $\frac{3}{8}$ in. thiek, being
aced on the top of eaeh course, exeept on the top
urse, whieh has 3 in. of breeze. The top of the up-
ght is finished by a close bolt of burnt bricks. The
right is built with an cqual battcr on each side, its
idth diminishing from six brieks lcngthways at the
ise to three brieks lengthways at the top. In order
at the upright should be perfectly firm, it is neeessary
at thc bricks should be well tied in at the angles;
d, in order to obtain the proper width, the brieks
e placed in a variety of positions, so that no very
gular bond is preserved, as it is of more consequence
keep the batter uniform.

The close bolts first commenced, and whieh form the
iter casing of the clamp, are not built close to the raw
ricks, there being a small space left between the elamp
d the close bolting, whieh is filled up with breeze.
he close bolts, howevcr, are built with a greater batter
an the ends of the upright, so that they just toueh the
tter at thc 16th course, abovc whieh the elamp is built
ithout any external easing. When, however, the up-
ght is *topped*, and whilst the top elose bolting is going
, the easing is continued up to the top of the elamp.
his upper easing is ealled the *bestowing*, and eonsists
f five or six courses of burnt briek laid flat, forming a
ising $4\frac{1}{2}$ in. or half a briek thiek; and above the 6th
urse the brieks are laid on edge, forming a still
inner casing only 3 in. thiek. When the weather is

bad, and during the latter part of the brickmakin season, a little extra bestowing is given beyond what i here described. The great art in clamping consists i the proper construction of the upright, as the stabilit of the clamp depends entirely upon it.

32. *Necks.*—The remainder of the clamp consists o a number of necks or walls leaning against the upright They are built in precisely the same way as the upright as regards invert, close bolts, paving, scintling, breez and end lifts. But there is this essential difference, viz that they are *parallel* walls, built in alternate courses c headers and stretchers laid on edge, each heading cours in one neck being opposite to a stretching course in th next neck, and *vice versâ.* The thickness of each nec is made up of three bricks lengthways in the headin courses, and ten bricks edgeways in the stretchin courses. The necks are close bolted at top, and b stowed in the same manner as the upright. When th last necks have been built, the ends of the clamp a close bolted, and bestowed in the same way as the side and this operation completes the clamp.

33. *Firing.*—The number of necks on each side the upright may be extended to eight or nine, witho an additional live hole; but if this limit be exceede additional live holes are required, according to th judgment of the brickmaker or the demand for brick the live holes are placed seven, eight, or nine nec apart. It is not necessary that the additional live hol should pass under the centres of the necks, and it more convenient to form each live hole so that the fa of the last-built neck shall form one of its sides.

In the close bolting surrounding the clamp, two bric are left out opposite the end of each live hole, and each of these openings a fire is applied made of coa

d wood heaped up in a brick fire-place built round e opening, and known by the name of a *devil-stove*. ne fire is kept up for about a day, until the faggots in e live hole are thoroughly ignited, and as soon as this found to be the case, the fire is removed, and the outh of the live hole stopped with bricks, and plastered er with clay. In firing a large clamp with many live oles, it should be begun at one end only, the live holes ing fired in succession, one after the other.

The bricks at the outside of the clamp are under-urnt; they are called *burnovers*, and are laid aside r reburning in the next clamp that may be built. he bricks near the live holes are generally partially elted and run together in masses called clinkers or urrs. The bricks which are not fully burnt are called ace bricks, and are sold at a low price, being unfit for utside work, or situations where they will be subjected much pressure. The clinkers are sold by the cart-oad, for rockwork in gardens and similar purposes.

34. The quantity of breeze required varies much with he quality of the earth. The usual proportions for very 100,000 bricks are about 35 chaldrons of the sifted shes, mixed with the brick-earth, and about 12 chal-rons of the cinders or breeze to light the clamp.

The quantity of fuel to the live holes it is difficult to alculate; about 10*s*. may be taken as the average cost f coals and wood for every 100,000 bricks.

35. If the proportion of breeze be too small, the ricks will be underburned, and will be tender and of pale colour. If too much fuel be used, there is danger of the bricks fusing and running into a blackish slag. No rules can be laid down for avoiding these errors, s the management of the breeze must depend upon the uality of the earth, and can only be learnt from

experience, some brick-earths being much more fusible than others.

36. The time of burning varies considerably. If expedition is requisite, the flues are placed near together, and the burning may be completed in a fortnight or three weeks; but, if time is no object, the flues are further apart, and the clamp is allowed to burn off more slowly.

37. Another system of clamping is to begin at one end and to follow with the necks in one direction only. This is done when the clamp ground is partly occupied by the hacks, so as to render it impossible to commence at the centre. When this system is adopted, the clamping begins with the erection of an end-wall, termed the *upright* and *outside*, which is made to batter very considerably on the outside, but of which the inside face is vertical. As regards dimensions and modes of building the outside and upright is built in the same way as the ordinary upright, but it has, of course, no live hole under it, the first live hole being provided in the *centre* of the 2nd or 3rd neck. In the style of clamping the necks are all upright. The live holes are placed at every 8th or 9th neck, as in the usual system.

38. We now proceed to describe the principal variations in the methods of clamping practised in different brick-yards.

Paving.—The practice with regard to the paving of burnt bricks is very variable. Some clampers omit it altogether; others pave only where clamping for the first time on a new clamp ground.

Scintles.—When burnt bricks run short, as in building the first clamp on a new ground, the second course is laid with raw bricks. This, however, is a very objectionable practice.

Live Holes.—The live holes are sometimes close-lted at the sides, to prevent the breeze from the intles falling into them. This, however, is not often one, and its utility is questionable.

Breeze.—Some clampers put the 7 in. stratum of reeze on the top of the scintles, instead of placing it ver the 1st course of raw bricks; very frequently the reeze is dispensed with after the 2 in. stratum, with ne exception of the top layer. All clampers, however, gree as to the necessity of having the 7 in., 4 in., and in. layers.

39. The several descriptions of bricks made for the ondon market, and their relative prices, as given in he *Builders' and Contractors' Price Book*, for 1862 are s under, viz.:—

	Price per 1,000. £	s.	d.
Malm cutters	5	5	0
,, seconds	3	12	0
,, paviours	3	2	0
,, pickings	3	2	0
,, stocks	2	7	0
,, roughs	1	18	0
,, place	1	10	0
Common stocks	2	2	0
,, roughs	1	16	0
,, place	1	8	0
Red stocks	2	5	0
,, rubbers	3	4	0
Paving bricks	2	10	0
Dutch clinkers	2	5	0

The prices of the various kinds of fire-bricks will be found at page 18.

The bricks commonly sold are known by the following terms:—

Cutters.—These are the softest, and are used for gauged arches and other rubbed work.

Malms.—These are the best building bricks, and are only used in the best descriptions of brickwork; colour yellow.

Seconds.—These are sorted from the best qualities and are much used for the fronts of buildings of superior class.

Paviours.—These are excellent building bricks, being sound, hard, well shaped, and of good colour. They must not be confounded with paving bricks, having nothing in common with them but their name.

Pickings.—These are good bricks, but soft, and inferior to the best paviours.

Rough Paviours.—These are the roughest pickings from the paviours.

Washed Stocks.—These are the bricks commonly used for ordinary brickwork, and are the worst description of malms.

Grey Stocks.—These are good bricks, but of irregular colour, and are not suited for face work.

Rough Stocks.—These are, as their name implies, very rough as regards shape and colour, and not suited for good work, although hard and sound.

Grizzles.—These are somewhat tender, and only fit for inside work.

Place Bricks.—These are only fit for common purposes, and should not be used for permanent erections.

Shuffs.—These are unsound and *shuffy*—that is, full of shakes.

Burrs or Clinkers.—These are only used for making artificial rockwork for cascades or gardens, &c.

Bats.—These are merely refuse.

It may be here observed, that at the brickworks round London the bricks made are usually in the form of regular parallelopipedons, 9 in. long, $4\frac{1}{2}$ in. wide, and 3 in. thick. If in the execution of a piece of brickwork, bricks of other shapes are required, it was formerly the practice, and still sometimes is, for the bricklayer to cut

ordinary bricks to the required shape. This practice, destructive to sound bond and good work, cannot be strongly reprehended;* especially now that the nufacture is free from the trammels of the excise re can be no excuse for not making bricks of a great iety of shapes for various purposes.

10. *Brickmaking at Cheshunt.*—In the "Illustrations Arts and Manufactures," by Mr. Arthur Aikin, is a uable paper on pottery and brickmaking, the perusal which is strongly recommended to the reader. The lowing notice is there given of the Cheshunt bricks:— At Cheshunt, in Hertfordshire, is a bed of malm earth the finest quality, no less than 25 ft. in depth; from s are made the best small kiln-burnt bricks, called viers." Not having an opportunity of personally amining the Cheshunt works, the author requested r. B. P. Stockman to do so, and, in reply, received e following communication, from which it appears that n burning has been now disused for some time at eshunt; clamping being now generally adopted:—

"There are no bricks now made near London of tural malm; the once well-known bed at Grays in sex has been exhausted some years. No one can form me of any bed of natural malm except that at eshunt, and I was told, previous to my going there, at I should not find the works conducted as I had en led to expect from your letter.

"There are only two brickmakers at Cheshunt, and, om going over their works, I am able to vouch for e accuracy of the following particulars.

* The brick columns, whose failure caused the frightful accident which curred in January, A.D. 1848, during the erection of the new buildings the Euston Station of the North Western Railway, were built in this y. The additional cost of bricks made expressly for the work, of such ms as would have bonded properly together without any cutting, would ve been very trifling.

"There is a bed of natural malm, and a bed close to it of ordinary brick-earth, which also contains malm. When they make malms, which they were not doing at the time of my visit, they do not use the natural malm earth by itself, but wash and mix chalk with it, and I am told that they *never* have made malms without adding chalk to the natural earth, although the proportion is small compared to that required for the other bed from which they also make malms. The earth is soiled with ashes precisely in the same way as in the London works, and turned over and pugged in the same kind of pug-mill. The bricks are hacked and *clamped*, as in London, and there are *none* burnt in kilns, nor have been for many years. There are no kilns on the ground, and no kiln burning of any description, though in former years there used to be kilns for bricks and tiles, and also for glazed ware.

"The bricks made at Cheshunt are very superior to the London bricks; in fact, the stock made there is really a kind of malm brick, and the malms themselves, as you may suppose, are perfection. I examined the brick-earth from both pits, and saw the several processes of moulding, hacking, scintling, and clamping going on. The names of the different qualities are the same as in London; but, as regards quality, some of the common descriptions are equal to the London malms, and I believe the shuffs would be sold for malms in London."

41. Brickmaking is carried on to a great extent round the metropolis, but the principal brick-fields are situated north of the Thames.

III. COST OF MANUFACTURE.*

42. We propose to consider the cost of manufacture ıder three heads, viz.:—

1. Materials and fuel.
2. Machinery and tools.
3. Labour.

I. MATERIALS AND FUEL.

43. *Clay.*—The cost of brick-earth must depend very uch on the circumstances of the locality, but it is ually considered to be worth 2*s.* 6*d.* per 1,000 bricks, clusive of getting.

44. *Chalk.*—The cost of chalk is trifling where the ɔrks have the advantage of water carriage, as it can brought to the canal wharfs round London at 2*s.* 10*d.* r ton. To this must be added the cartage, which, in me cases, must be a serious expense.

45. *Sand.*—The above remarks apply to the mould-g sand; which is brought from the bed of the Thames, ar Woolwich, in barges to the canal wharfs at 2*s.* r ton, a ton being about 1¼ cubic yard. To this must added cartage, and labour in drying the sand to ake it fit for use.

It is difficult to say what quantity of sand is used per 000 bricks, but the cost may be taken approximately from 6*d.* to 8*d.* per 1,000 bricks.

46. *Breeze.*—The quantity of breeze required varies cording to circumstances; the proportion may be ken to range from 12 to 20 chaldrons per 100,000 icks. The cost of breeze may be taken at about 10*s.*

* The estimates under this head must be considered as belonging to date of the first edition of this work (1850), but later prices will be ınd at page 162.

per chaldron. It may here be mentioned, that i London stringent regulations are in force to preven householders from making use of their domestic ashes which are collected by parties who contract with th parish authorities for this privilege.

In the Midland Counties the domestic ashes ar generally used for manure, the ashes being thrown int the cesspools, an arrangement which would not be per mitted in the metropolis. This mode of disposing c the domestic ashes completely prevents the use of breez in the manufacture of bricks in the district where it i practised.

47. *Soil.*—The cost of soiling cannot be very accu rately ascertained. The quantity of soil required de pends much on the quality of the brick-earth; 3 chaldrons per 100,000 bricks may be considered a fai average. The cost per chaldron may be taken at 8*s*. t 9*s*. To this must be added the cost of barrowing to th clay heap, say 10*s*. to 12*s*. per 100,000 bricks.

48. *Coals and Wood.*—The quantity of faggots re quired will depend on the number of live holes. Th item of expense is very trifling, say 10*s*. per 100,000 fo faggots and coals to light the clamp.

49. *Water.*—The water required for the washing mills is pumped into the troughs as before describe and as shown in the drawings of the washing-mill fig. 7. That which is used in tempering the clay brought in buckets from the nearest pond on the work In some yards the supply is drawn from wells by th contrivance known in the East as a shadoof, and in us at the present day in Germany, and throughout Russi This simple contrivance is described at page 3 of M Glynn's "Rudimentary Treatise on the Constructio of Cranes and Machinery," and the reader is ther

e referred to the description and wood-cut there
ven.

It may, however, be worth while to remark, that there scarcely any difference between the ancient *shadoof* ed in Egypt in the time of the Israelitish bondage d that in common use at Stoke Newington, and other ices near London, in our own time.

It is impossible to make any calculation as to the oportionate cost of the necessary supply of water a brickfield, as it forms a portion of the cost of mpering, and cannot be separated from it.

II. MACHINERY AND TOOLS.

50. The average cost of the machinery and tools reired in a London brickfield is about as follows:—

		£	s.	d.
Chalk and clay mills, together	£60 to	70	0	0
Pug-mill		10	0	0
Cuckhold	5s. to	0	6	0
For each moulder are required—				
1 moulding stool, complete, at . .		0	14	0
1 mould " . .		0	10	6
3 sets of pallets, 26 in each set . .	at 3s.	0	9	0
3 bearing-off barrows	at 12s.	1	16	0

In addition to the above are required, a few planks, hovels, barrows, buckets, sieves, and other articles, the ggregate cost of which it is impossible to estimate.

No buildings are required for the actual manufacture. It is, however, usual for the foreman, or "moulder," o live at the field. Stabling may be required or not, ccording to circumstances and locality.

III. LABOUR.

51. The cost of labour, &c., may be taken as follows:—

	Per 1,000 bricks		
	£	s.	d.
Rent of field	0	0	3
Ashes	0	4	6
Removing top mould	0	0	2
Digging earth	0	0	6
Soiling and turning earth	0	0	6
Chalk and expense of washing	0	0	3
Moulding	0	4	4
Horse grinding earth	0	0	6
Sand	0	0	6
Straw and hurdles	0	0	4
Setting	0	1	8
Bolting, sorting, &c.	0	0	6
Loading	0	0	6
Implements, &c.	0	0	6
Superintendence	0	0	9
Interest on capital	0	0	9
Royalty	0	2	0
Bad debts	0	1	0
Preparing hacks, obtaining water, making roads, coals and wood in burning, materials for building sand-houses	0	0	6
	1	0	0

This is the actual cost for every thousand, as given in the *Builder* for 1854; and in order to secure a fair profit, *i. e.*, about 20 per cent., the stock bricks must be sold at £1 8*s.* per 1,000; while the place bricks will sell at from 15*s.* to £1, the grizzles and rough bricks at from 19*s.* to £1 3*s.*, and the shuffs at from 8*s.* to 10*s.* per 1,000.

BRICKMAKING AT THE COPENHAGEN TUNNEL, ON THE GREAT NORTHERN RAILWAY.

After the above description of the ordinary practice of London brickmakers was written, Messrs. Pearce and Smith, the contractors for the Copenhagen Tunnel

the line of the Great Northern Railway, commenced ckmaking on a large scale at the tunnel-works; and the mode of manufacture practised by them was new the time in London, a short notice of it may be eresting:—

The clay is neither weathered nor tempered, but as n as dug is wheeled up an incline to the grinding-ll, which consists of a single pair of cast-iron rollers, ven by a steam-engine. The clay is mixed with a tain proportion of sifted ashes, and, passing between rollers, falls into a shed, whence it is, without further paration, wheeled to the moulders.

The moulds are of wood, and the process employed is it known as slop-moulding.

The moulding and drying processes are both carried in drying houses, with flues under the floors.

The bricks, as soon as moulded, are carried one by e to the floors, where they remain until dry, when, thout being hacked, they are wheeled to the kilns.

The kilns are of the construction commonly used in e Midland Counties, but have no sheds at the sides to elter the fires. The fuel used is coal.

The bricks thus made are of an irregular reddish own colour, and of fair average quality.

On first commencing operations, Messrs. Pearce and nith made a large quantity of bricks without any lmixture of ashes, sand only being added to diminish e contraction of the clay. These bricks burnt of a ear red colour, and were mostly very hard, but proved ittle, and were apt to become cracked in burning.

Amongst other novelties adopted, may be mentioned e use of saw-dust in lieu of sand,* the latter material

* It may be necessary, perhaps, to remind the reader that sand is used r many purposes besides that of sanding the brick-mould.

being very costly, whilst the former is supplied on t
works from a saw-mill worked by a steam-engine, whi
at the same time drives the mortar-mill, and works t
lifts at two of the tunnel shafts.

Reference to Illustrations accompanying the for going Account of Brickmaking in the vicinity London.

52.—Fig. 1. *General Plan of a Brickwork.*
(Scale 40 ft. to an inch.)

A. The chalk-mill.
B. The clay washing-mill.
C. The pump.
D. The shoot to the brick-earth.
E. The brick-earth turned over in readiness to receive the mal
F. The pug-mill.
G. The moulding stool.
H. The hack ground.
K.K. Clamps.

53. *The Chalk-mill.*

Figs. 2 and 3. Section and Plan. (Scale 10 ft. to an inch.)
a.a. Grinding-wheels.
b. Inlet from pump.
c. Outlet to clay washing-mill.
Details. (Scale 5 ft. to an inch.)
Fig. 4. Grinding-wheel.
Fig. 5. Mode of connecting the axle-tree of the grinding-wheels v the centre shaft.

The mill consists of a circular trough lined with bri work, and furnished with a pair of heavy wheels w spiked tires, which, being drawn round by horses, cru and grind the chalk until it is reduced to a pulp. T wheels are shown in detail in fig. 4. It is necess that they should accommodate themselves to the le of the chalk in the trough, and to effect this, the fram

which the axle-tree forms a part is secured to the ntre shaft by a staple, as shown in fig. 5, which ows the whole of the timbering to rise or fall, as may requisite. The ecntre shaft is a bar of iron, steadied being built up in a mass of brickwork. The yoke ams are kept at the proper height, and their weight pported by eommon light chaise wheels, about 2 ft. 6 in. ametcr, whieh run on the outside of the horsc traek. ne mill represented in these engravings is mounted for o horses; many mills, however, have but one.

54. *The Clay-washing Mill.*

Figs. 6 and 7. Plan and elevation. (Scale 10 ft. to an inch.)
a. The inlet from the chalk-mill.
b. The outlet to the shoot.
c.c. The harrows.
d.d. The cutters.
e. The pump.
Details. (Scale $1\frac{1}{4}$ in. to 5 ft.)
Fig. 8. The cutters.
Fig. 9. The outlet to the shoot, and the strainer.
Fig. 10. The strainer.

The mill consists of a cireular trough of larger dimenons than that of the ehalk-mill, also lined with brickork, and furnished with a two-horse gin, to whieh are ttached knives and harrows, which, in their passage ound the trough, eut up the clay and incorporate it ith the pulp from the chalk-mill. The framing of the in is very simple, and requires no description. The nives, or cutters, are placed in two sets, four in each. hey are fixed in an upright position, and steadied to heir work by chains, and by being bolted together with olts passing through tubular distance pieces, as shown n fig. 8. The knives eut the clay and clear the way or the harrows, which are similar to those used for gricultural purposes, and are merely suspended by

chains from the timber framing. The pump is worl by the horizontal wheel F, fig. 7, which is provi with friction rollers on its rim, for the purpose of lift the lever G, which raises the lever of the pump by me of the spindle H. The outlet to the shoots is simpl square trunk made of 2 in. plank. It is furnished w a brass grating, or strainer, shown in fig. 10. The b are $\frac{3}{4}$ in. wide, and $\frac{1}{4}$ in. apart, so that even small sto will not pass through. This grating is fixed in groo so that it can be lifted out of its place by the hand when required.

55. *The Pug-mill.*

Fig. 11. Elevation. (Scale 4 ft. to an inch.)

a. The yoke arm.

b. The opening for the ejectment of the earth when *groun*

c. The brick-earth surrounding the mill, on which is inclined barrow road to the top of the mill.

Fig. 12. Section. (Scale 2 ft. to an inch.)

a.a. Force knives. These are not provided with cross kn their purpose being merely to force the earth downw and out at the ejectment hole.

56.—Fig. 13. *Isometrical View of the Moulding Sto*
(Scale 4 ft. to an inch.)

a. The lump of ground earth from the pug-mill.

b. The moulder's sand.

c. The clot-moulder's sand.

d. The bottom of the mould, termed the *stock-board.*

e. The water-tub.

f. The *page,* which is formed of two rods of $\frac{5}{8}$ths of an inch ro or square iron, nailed down at each end to the woo rails or sleepers on which they rest. The use of the p is to slide the new bricks, with their pallets, away from moulder with facility.

g. The pallets in their proper position for use.

h. A newly-made brick just slidden from the moulder, and re for the taking-off boy.

k. The moulder's place.

m. The clot-moulder's place.

n. The taking-off boy's place.

o. The *cuckhold,* a concave shovel used for cutting off the grou earth as it is ejected from the pug-mill.

–Fig. 14. *Isometrical View of the Brick Mould, ith its detached bottom or Stock-board.* (Scale 2 in. › a foot.)

a.a.a. The iron pegs on which the mould rests during the operation of moulding. They are driven into the stool in the positions shown in the drawing; their height from the stool regulates the thickness of the brick. The mould is lined throughout with sheet-iron, which is turned over the edges of the mould at the top and bottom.

–Fig. 15. *The Hack Barrow*—loaded. (Scale 2 ft. to an inch.)

;. 16. *The hack barrow*—unloaded. (Scale 2 ft. to an inch.)

59. *The Clamp.*

;. 17. Transverse section (parallel to necks). (Scale 10 ft. to an)

;. 18. Longitudinal ditto ditto ditto.

a. The upright.

b.b. Close bolts.

c. Live hole.

d. Bestowing.

Details. (Scale 2 ft. to an inch.)

;. 19. Plan of the lower course of scintles.

;. 20. Plan of the upper course of scintles.

. The live hole.

It should be understood that the directions of the scintles, as well as that of the paving below it, are changed for every neck, so as to correspond with the upper work, as shown in the figures.

;. 21. Detail of the end of the upright, showing the paving, the ing, the live hole, and the 7 in., 4 in., and 2 in. courses of breeze.

CHAPTER VI.

LONDON TILERIES.

. The general term, "Tile Manufacture," is so comiensive, that it would be impossible, within the limits little volume like the present, to give anything like mplete account of the manufacture of the different

articles made at a large tilery; we only propose, the-fore, in the present chapter, to give a succinct acco of the manufacture of pantiles, as carried on at London tileries, which will serve to give the reade general idea of the nature of the processes employe tile-making. It must, however, be borne in mind, t although the principle of proceeding is the same in e case, there are no two articles made exactly in the s way, the moulding and subsequent processes b carried on in a different manner, and with diffe tools and implements, for every description of artic

The manufacture of plain tiles and drain tiles already been described in Chap. IV., to which reader is referred, as also to the supplementary cha at page 220.

2. The following is a list of the principal art made at the London tileries:—

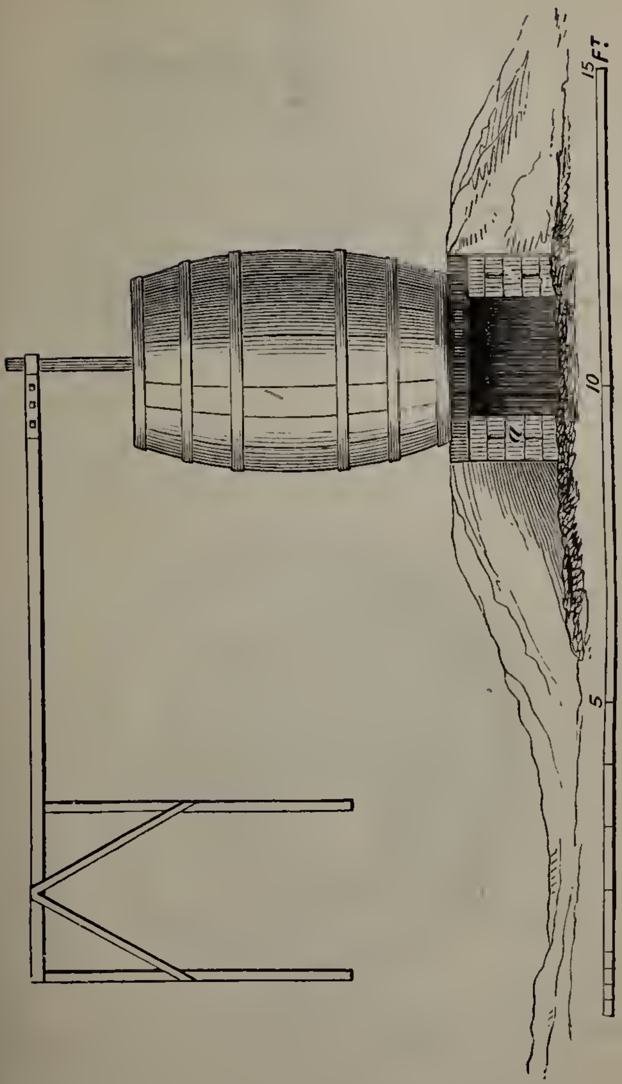
Oven tiles.	Kiln bricks.
10-in. paving tiles.	Fire bricks.
Foot ditto.	Paving bricks.
Plain tiles.	Circulars (for setting copper
Pantiles.	Column bricks (for formi lumns).
Ridge tiles.	Chimney-pots.
Hip tiles.	Garden-pots.
Drain tiles.	Drain pipes.

And anything required to order.

For all these articles (excepting fire bricks) the clay is employed (mixed, for the making of paving oven tiles,* kiln bricks, paving bricks, circular br and column bricks, with a certain quantity of lo and they are all burnt in the same kiln, the fire b included; but each different article presents some liarity in the processes intervening between the pering and the burning, having its separate moul

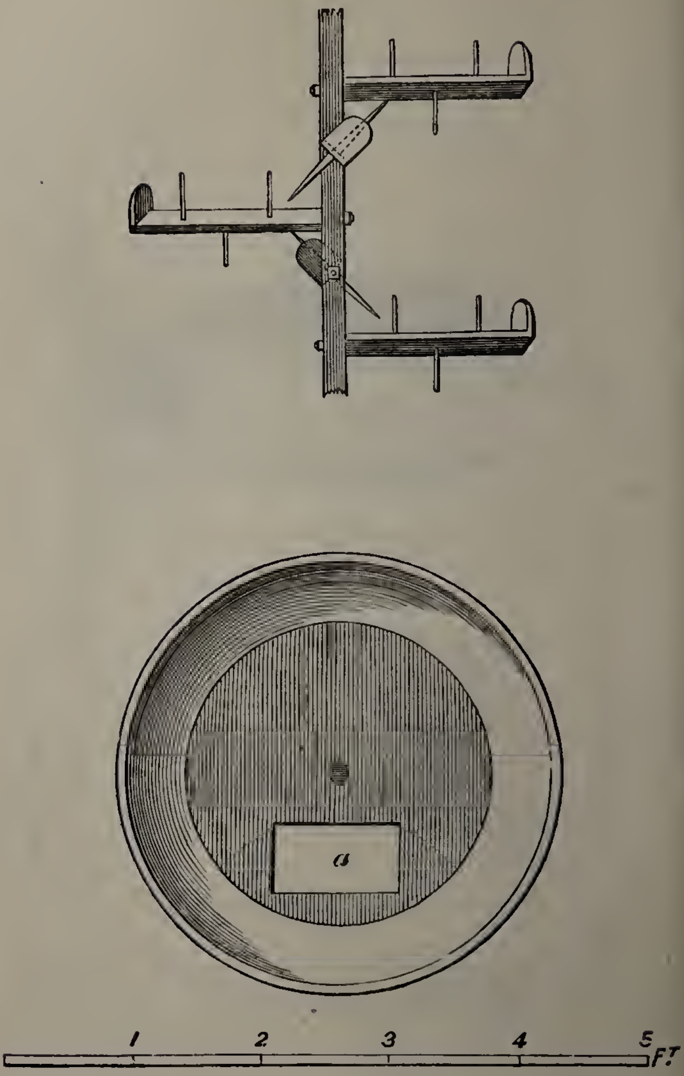
* For oven tiles the stuff must be of superior quality.

Fig. 1.



ɔol, frames, strike, &c., and being stacked and dried ferently. The details of these differences, however ʼen would our limits allow us to describe them), would ırcely be suited to the pages of a rudimentary work ꜰended for popular reading.

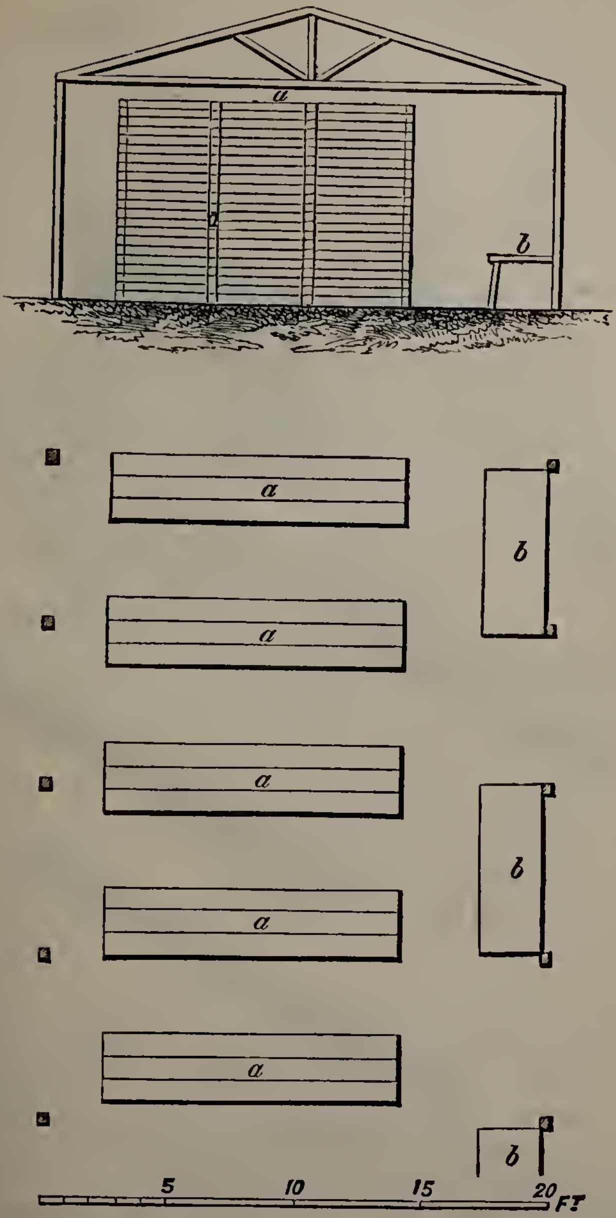
Figs. 2 and 3.



BUILDINGS AND PLANT.

3. *Pug-mill.*—The pug-mill used in tile makin
pugging, or, as it is termed, *grinding* the clay, c
considerably from that used in brick-making. Th
instead of being conical, is made to taper at both

Fig. 5.



the ejectment hole is at the bottom instead of in front, as in the brick pug-mill.

The knives, also, are made in a superior manner.

Fig. 4.

Fig. 7.

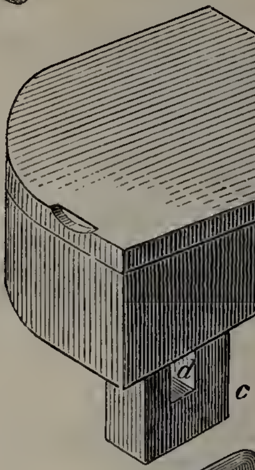


Fig. 8.

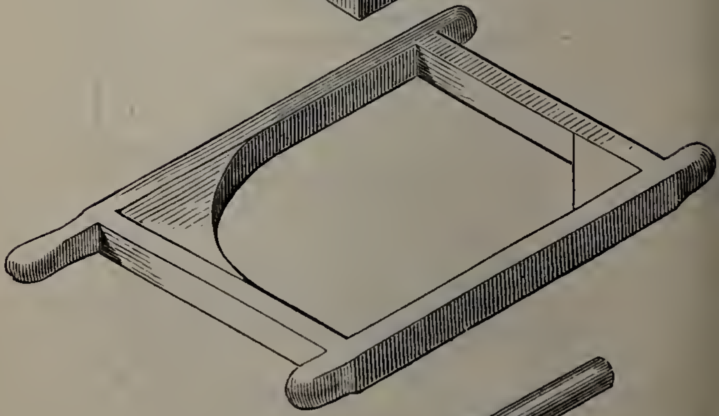
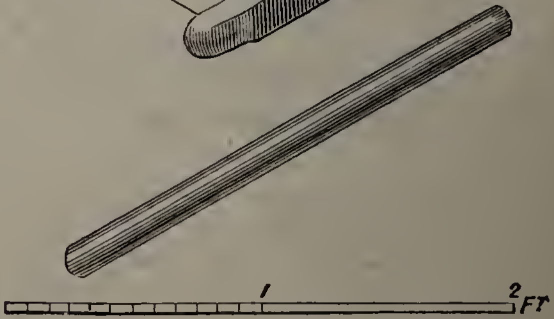


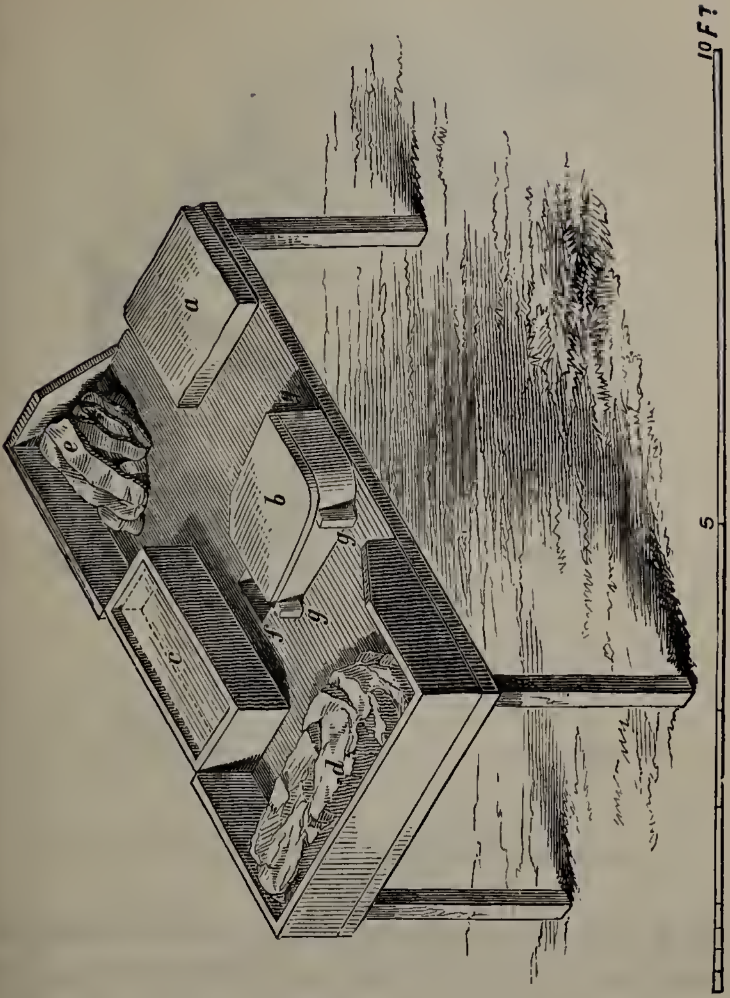
Fig. 9.



The mill is provided with force knives without cr
knives at top and bottom. See figures 1, 2, and 3.

The pug-mill is placed under cover in a shed ca
the *grinding* shed.

Fig. 6.

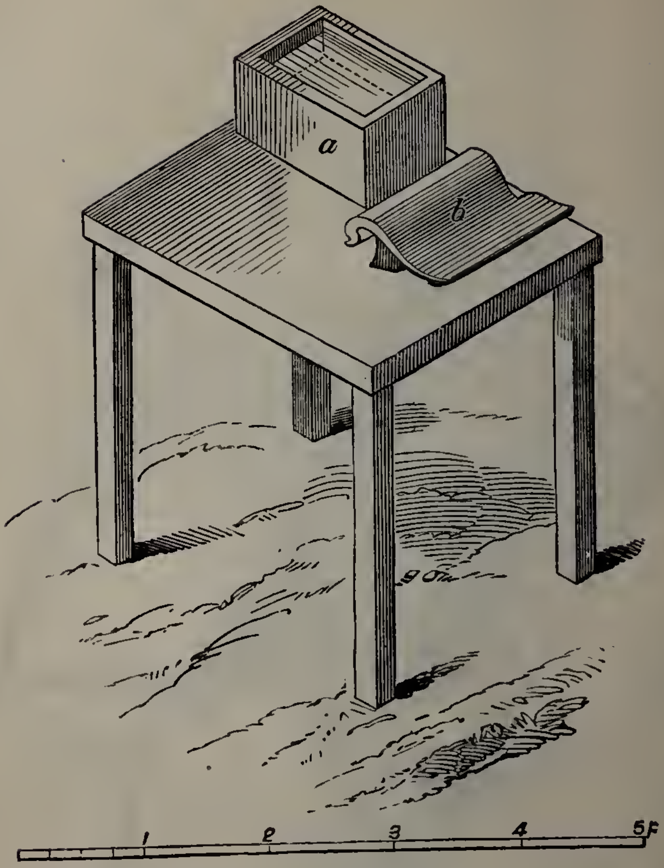


4. *The Sling,* fig. 4, is simply a piece of thin wire with two handles, used for cutting the clay.

5. *Moulding Shed.*—Tiles are made under cover in sheds about 7 yards wide, the length of the shed depending on the number of moulding tables, the area allotted to each table being about 7 yards in length by 4 yards in breadth.

The moulding tables are placed against one side of

Fig. 10.



the shed, and the remainder of the area is occupied b
the *blocks* or drying-shelves ; every shelf being forme
with three 1 in. planks placed edge to edge, and sepa
rated from each other by bricks placed edgewise at th
end of the planks, as well as at intermediate point
each block containing about 14 shelves, and thu
measuring 12 ft. long by 2 ft. 8 in. wide, and about 7 f
high. A passage way, 3 ft. wide, is left round th
blocks, to give free access to every part of them.

These details will be understood by reference to fig.

6. *The Pantile Table*, or moulding table, is shown

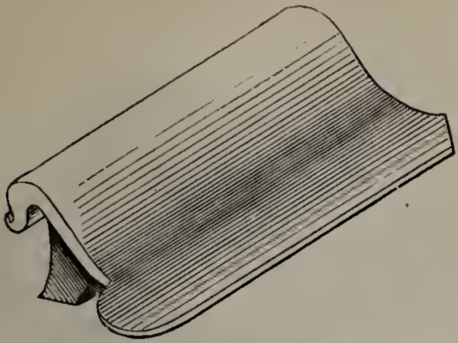


Fig. 11.

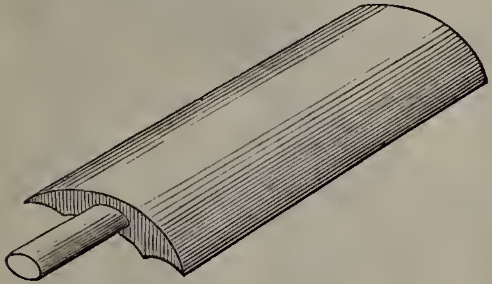


Fig. 12.

Fig. 16.

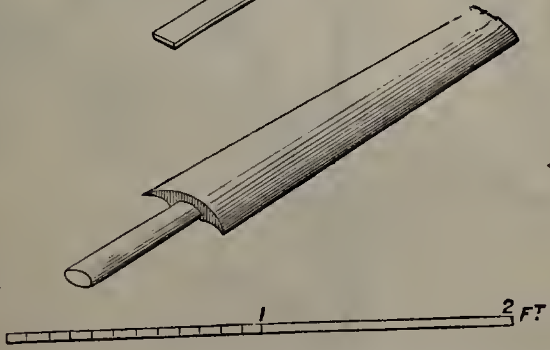


Fig. 15.

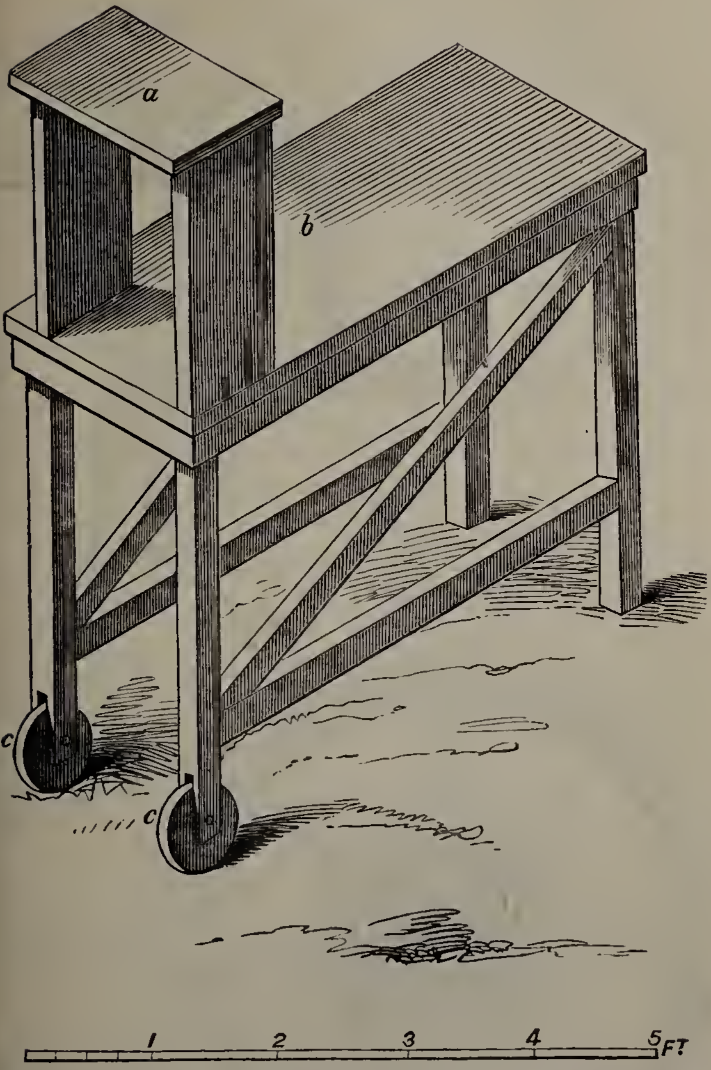
g. 6. It is furnished with a *trug* or trough, in which
ie moulder dips his hands when moulding, and with
block and stock-board, on which the tile mould is
laced in the operation of moulding.

7. *The Block and Stock-board* is shown in fig. 7.
'he two form one piece, which rests on the moulding
able, and is firmly keyed to it by means of a tenon on

Fig. 13.

the under side of the block passing through a mortice the table. Four pegs, driven into the table at the corne of the block and stock-board, serve as a support for t mould and regulate the thickness of the tile, $\frac{5}{8}$ in. bei the thickness of a pantile.

Fig. 14.

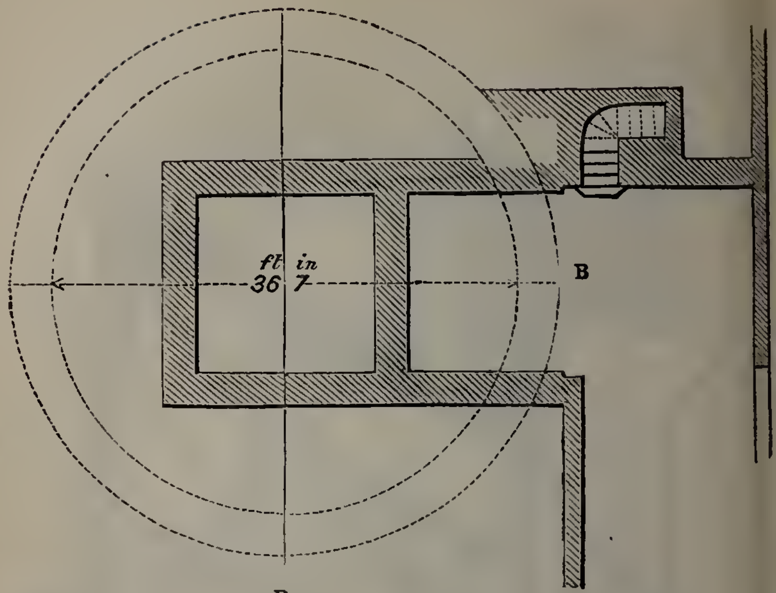


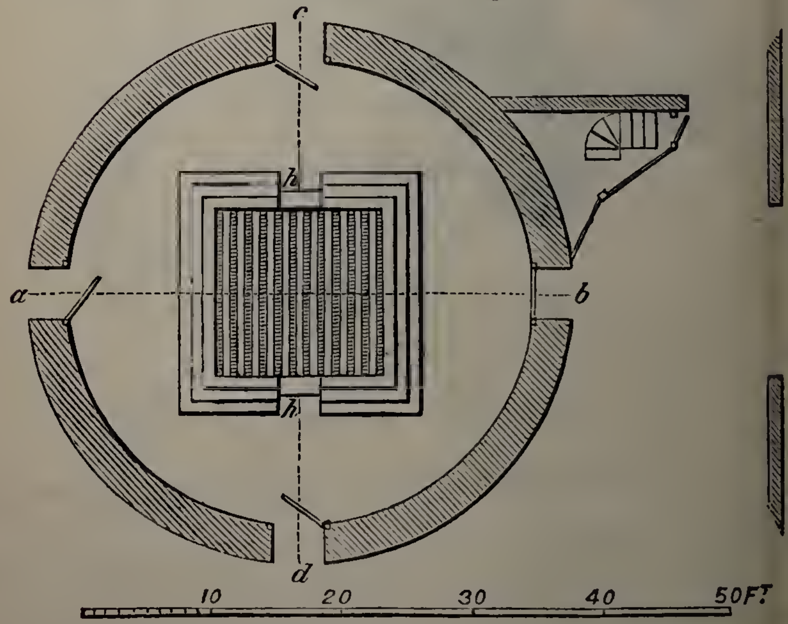
8. *The Tile Mould* is shown in fig. 8, and requires no articular description.

9. *The Roll*, fig. 9, is merely a round roller of a articular size, as shown by the scale, and is used for triking a smooth surface to the tile.

10. *The Washing-off Table*, fig. 10, is a stand with

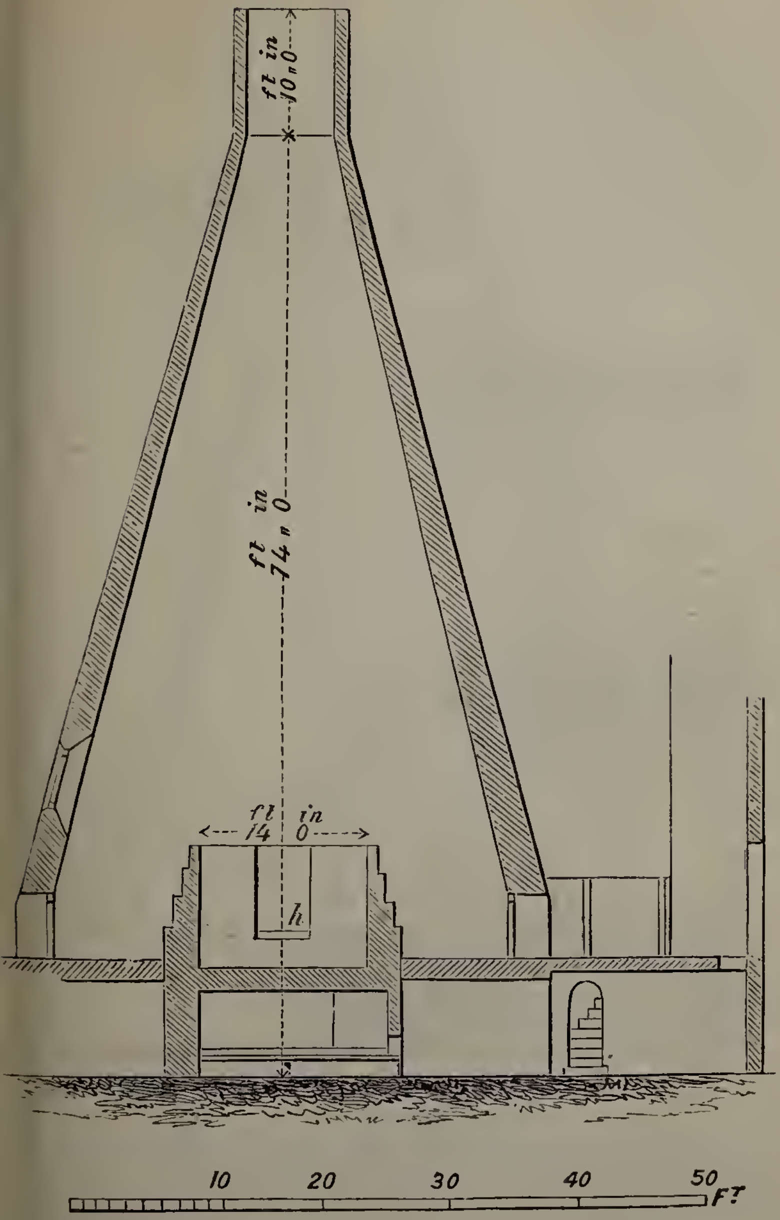
Figs. 17 and 18.





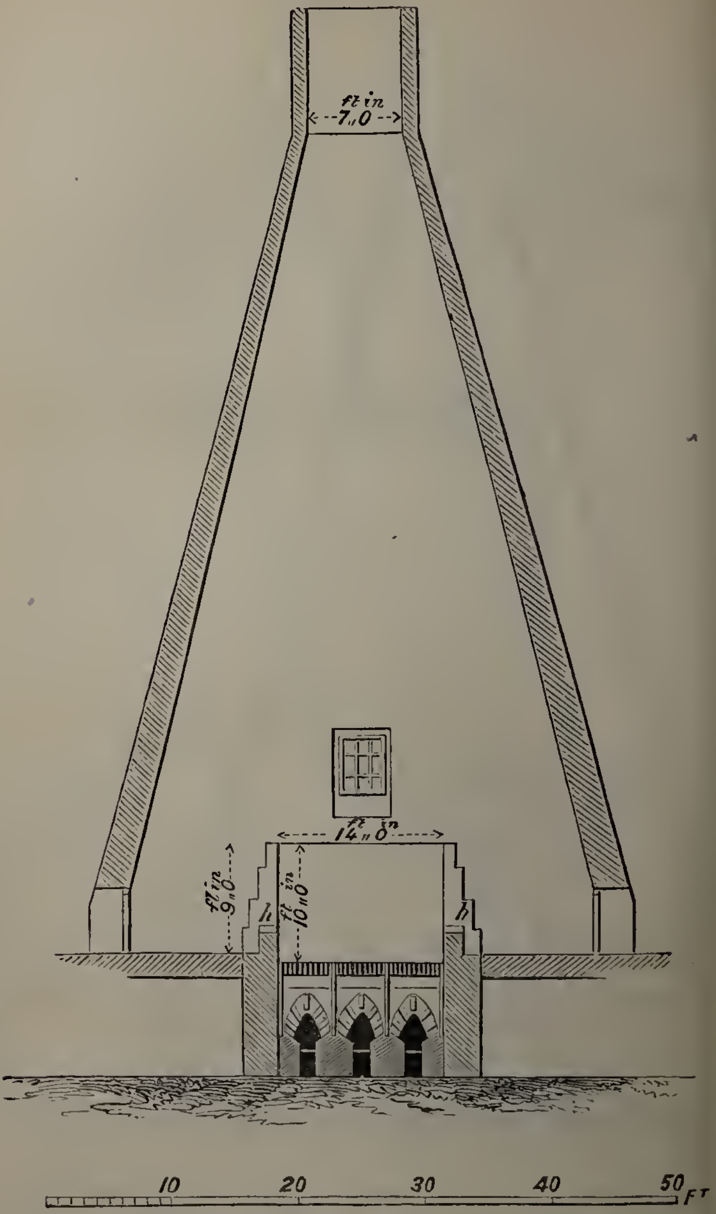
a water trough and a frame called the *Washing-*
Frame, see fig. 11, on which, when moulded, the tile

Fig. 19.



[w]ashed into a curved form. The washing-off table is [pl]aced at the left hand end of the pantile table, and [ne]ar the block.

Fig. 20.



11. *The Splayer*, fig. 12, is an instrument on wh
the tile is removed from the washing-off frame to
block.

12. *The Thwacking Frame*, fig. 13, is a frame

Fig. 21.

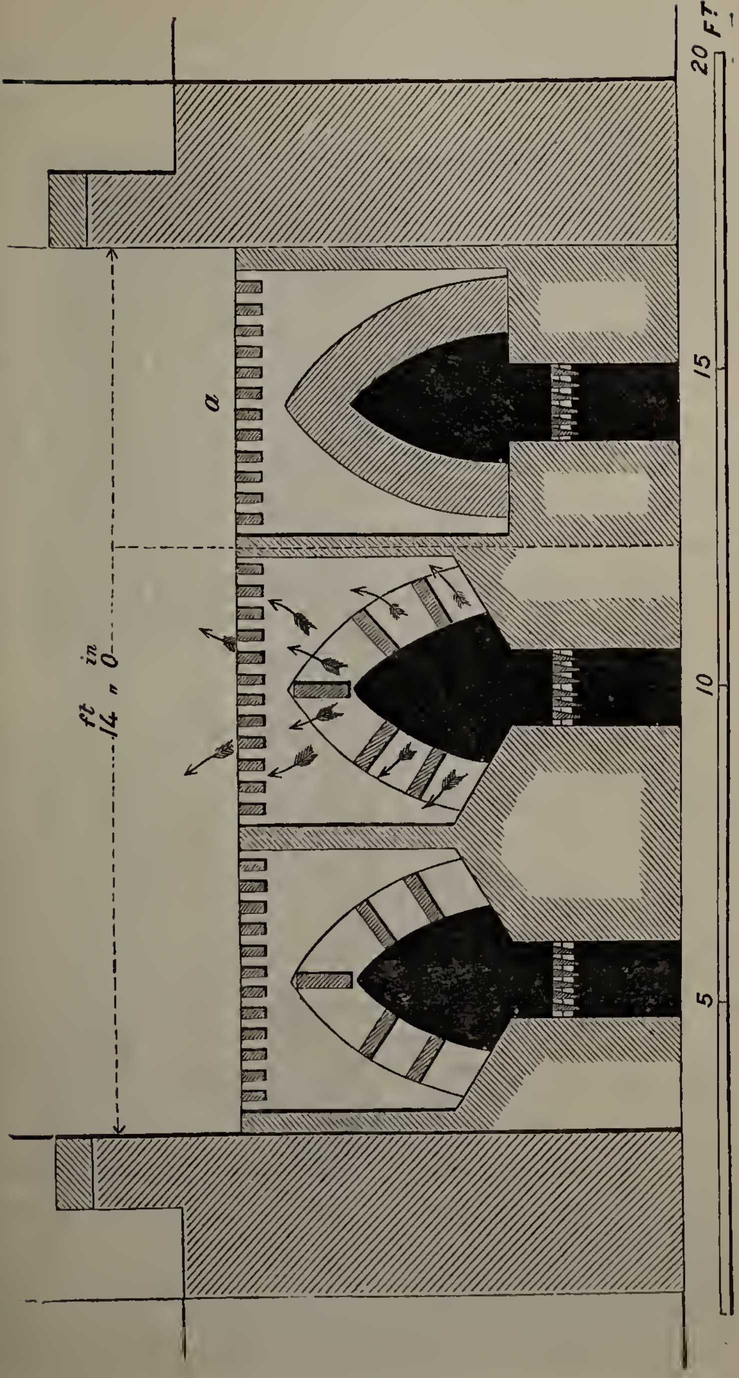
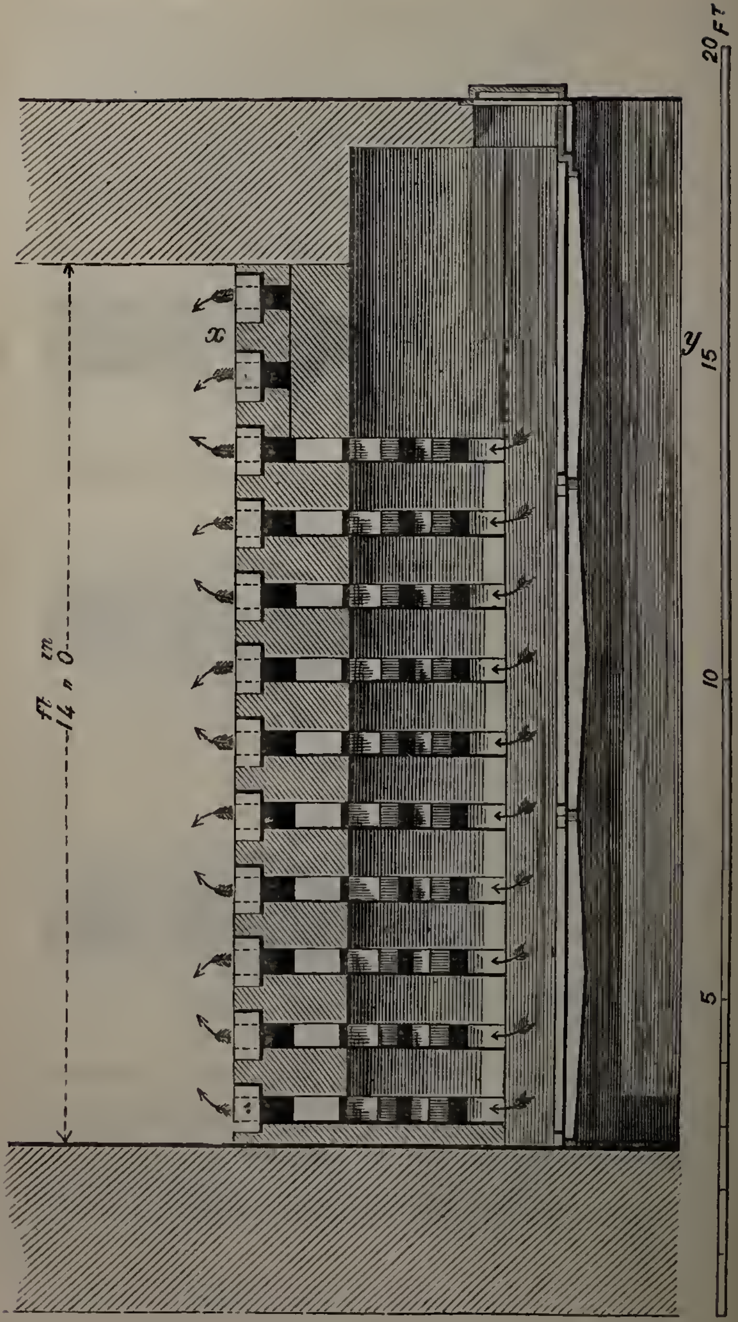


Fig. 22.



which the tile, when half dry, is *thwacked* or beaten with a *thwacker* (fig. 15), to correct any warping which may have taken place whilst drying in the block.

When thwacking those tiles taken from the bottom of the block, the thwacking frame is placed upon the *Thwacking Stool*, fig. 13; but when the tiles to be thwacked are at the top of the block, the thwacking frame is placed upon the *Thwacking Horse*, fig. 14, which brings it conveniently to their level.

The *Thwacking Knife*, fig. 16, is used for trimming the wing of the pantile immediately after thwacking.

13. *The Tile Kiln*, figs. 17, 18, 19, 20, 21, and 22, consists of a kiln with arched furnaces, enclosed in a conical building called a dome. The arrangement of the whole building will be clearly understood by reference to the figures, and to the detailed description at the end of this chapter.

PROCESS OF MANUFACTURE.

14. *Clay-getting and Weathering.*—The clay used for making tiles is purer and stronger than that used for making bricks, and consequently requires more care in its treatment.

When the clay is too strong, it is mixed with sand before passing it through the pug-mill, but this is not often required.

The weathering of the clay is performed by spreading it out in thin layers, about 2 in. thick, during the winter, and each layer is allowed to receive the benefit of at least one night's frost before the succeeding layer is placed over it. Sometimes the clay is spread out in the summer to be scorched by the sun, which effects the weathering equally well. The greater the heat, or

the sharper the frost, the thicker may be the layers, but 4 in. is the maximum thickness.

The object of the process of weathering is, to open the pores of the clay, and to separate the particles, that it may absorb water more readily in the subsequent process of mellowing.

The clay thus weathered is thrown into pits, where it is covered with water, and left for a considerable time to mellow, or ripen.

15. *Tempering.*—The process of tempering is performed simply by passing the clay through the pug-mill. If the clay be very foul, that is, full of stones, it is *slung* before using, and passed a second time through the mill. For chimney-pots and similar articles, the clay is slung either once or twice, and pugged, or, as it is called *ground*, twice or thrice, according to the nature of the clay, and the purpose to which it is to be applied.

16. *Slinging.*—The operation of slinging is as follows: as the clay issues from the ejectment hole of the pug-mill, it is cut into lengths of about 2 ft., with a sling. These lumps are taken by the slingers and cut up into slices, not exceeding $\frac{3}{4}$ in. in thickness, during which operation most of the stones fall out, and those which remain are picked out by hand. The clay thus freed from stones is once more ground, and is then ready for the moulder.

(N.B. In some parts of England the clay is freed from stones by sifting, and the tempering is performed by treading; this part of the work being done by boys who tread in a spiral track, so as to subject each portion of the mass to a uniform amount of kneading.)

17. *Moulding.*—The clay, as it issues from the mill is cut into lumps, called *pieces*, which are stacked on a rough bench in the grinding shed. A labourer cu

hese lumps in half, each half being called a *half-piece*, nd wheels these half-pieces one by one to the pantilc able.

A rough-moulder, generally a boy, takes the half-iece and *squares* it up, that is, beats it up into a slab ear the shape of the mould, and about 4 in. thick, from vhich he cuts off a thin slicc, the size of a tile, and asses it to the mouldcr.

The moulder, having sanded his stock-board, and laced his mould on the four pegs which rcgulate the hickness of the tilc, takes the slice of clay from the ough-moulder, and puts it into the mould. He then, vith very wet hands, smooths the surface, cutting off he superfluous clay with his hands, in long pieccs, called trippings, which are thrown to a corner of the table. 'his done, he strikes the surfacc level with the roll; and urning the tile out of the mould on the washing-off rame, with very wet hands washes it into a curved hape. He then strikcs it smartly with the splayer, and urns it over on that implement, on which he conveys it o the block, where he deposits the tile with the convex ide uppermost, and, the splayer being withdrawn, the le is left to dry. The button end of the tile is placed ıside the block.

18. *Thwacking.*—The tiles remain in the block until ıey are half dry, when they are taken out one by one, laced on the thwacking framc, and beaten with the ıwacker to perfect their shape.

The wing of each tile is then trimmed with the ıwacking knife, and the tiles replaced in thc block, still ith the convex side uppermost; but this timc the button ıd is placed outside. The tiles then remain in the lock until ready for kilning.

It should be observed that the tiles flatten slightly

whilst in the block, and for this reason the washing-off frame is made a little more convex than the thwacking frame, which corresponds to the permanent form of the tile.

19. *Kilning.*—In setting the kiln, a course of vitrified bricks is laid at the bottom, herring-bone fashion, the bricks being placed $1\frac{1}{2}$ in. apart. On this foundation the tiles are stacked as closely as they will lie, in an upright position, one course above another. As the body of the kiln is filled, the hatchways are bricked up with old bricks, and when the kiln is topped, they are plastered over with loam or clay. The top is then covered with one course of unburnt tiles, placed flat, and lastly, upon these a course of old pantiles is loosely laid.

The fires are lighted on Monday morning, and are not put out until Saturday evening, whatever the articles in the kiln.

The fuel used is coal, and the quantity consumed at each burning about eight tons. This, however, varies with the kind of articles to be burnt,—hollow goods, as chimney-pots, garden-pots, &c., requiring less than more solid articles. Foot tiles, oven ditto, and 10-in. ditto, are stacked in the kiln the same way as paving bricks. The covering on the top of the kiln varies in thickness, according to the sort of goods to be fired.

COST OF MANUFACTURE.*

20. From the manufacture of tiles being carried on under cover, the establishment of a large tile-work involves a considerable amount of capital. The kiln

* The estimates here given refer to the First Edition, except where otherwise stated.

ed in London is very costly, such a one as we have own in figs. 17 to 22 costing in its erection no less an £2,000.

The cost of making pantiles is about as follows, per 000:—

	£	s.	d.
Clay—this is usually included in the rent, but, if purchased separately, may be taken at 2*s.* 6*d.* per yard cube—2¼ yards cube make 1,000 pantiles	0	5	7½
Weathering clay	0	5	0
Mellowing ditto, and grinding once	0	2	0
Add for horsing the pug-mill	0	1	6
If slung and ground a second time, add	0	2	0
Moulding, including all labour in fetching clay from mill, moulding, washing, blocking, thwacking, and blocking second time	0	10	0
Setting and drawing kiln	0	3	0
Burning	0	15	0
Cost of making	2	4	1½
Rent, repairs, breakage, contingencies, and profit . .	1	5	10½
Selling price per 1,000 . . .	3	10	0

21. The following are the ordinary prices, in 1862, or a variety of articles, which will give an idea of the omparative amount of labour bestowed upon them :—

		£	s.	d.
Plain tiles	per 1,000	2	4	0
Patent tiles	,,	3	6	0
Pan, hip, or ridge tiles . .	,,	3	5	0
Ornamental plain tiles . . .	,,	3	4	0
Paving tiles, 9 in. . . .	,,	9	0	0
,, 10 ,, . . .	,,	12	0	0
,, 12 ,, . . .	,,	14	10	0
Mathematical tiles, red . . .	,,	3	0	0
,, white . .	,,	3	10	0
Oven tiles	each	0	0	9

22. The above sketch of the manufacture of pantiles will give the reader a general idea of the processes used n tile-making, but every article presents some peculiarity of manufacture. Plain tiles are dried on flats, called *Place Grounds*. Hip and ridge tiles are washed

and thwacked in a similar manner to pantiles. Drai tiles are only washed. Paving tiles and oven tiles ar stricken with a flat strike instead of the roll, and ar not washed, but they are thwacked and dressed with knife.

23. *Description of Illustrations.*

Figs. 1, 2, and 3. The pug-mill.

The pug mill used in tile-making is different from that used in bricl making, as will readily be seen from the figures.

Fig. 1. Elevation of pug-mill. (Scale $\frac{1}{4}$ in. to the foot.)

Fig. 2. Details of the knives. (Scale $\frac{1}{2}$ in. to the foot.)

These knives are made in a superior manner to those of the bric pug-mills, both as regards strength and fitting. The mill is provid with force knives at top and bottom, which have no cross kniv attached to them.

Fig. 3. Cross section of the tub. (Scale $\frac{1}{2}$ in. to the foot.)

a. The ejectment hole, which is at the bottom of the tub, and n at the side, as in the brick pug-mill.

Fig. 4. The sling, or wire knife, used for cutting the clay into lengt as it issues from the pug-mill, and also for freeing the clay from ston (slinging).

Fig. 5. The tile shed, shown in plan and section. (Scale 10 ft. to t inch.)

a.a.a. The blocks, which consist of a series of shelves, on which t tiles are placed to dry. Each shelf is formed of three 11-in planks. The shelves are $4\frac{1}{2}$ in. apart, and are spaced off from ea other by bricks laid edgewise, at the end of the block, and al midway between these points.

b.b.b. The moulding tables.

Fig. 6. The pantile table, used for moulding pantiles. (Scale $\frac{3}{8}$ in. the foot.)

a. The half-piece squared up.

b. The block and stock-board.

c. The trug or trough.

d. The moulder's sand.

e. The strippings.

f. A hole in the table for sweepings to drop through.

g.g.g. The pegs on which the mould is placed. There are four these pegs; viz., one at each corner of the block and stock-boar and the distance to which they are driven below the top of t stock-board, determines the thickness of the tile.

Fig. 7. The block and stock-board. (Scale 1 in. to the foot.)

c. A tenon, which drops into a mortice in the table.

d. A mortice in *c*, by which the block and stock-board is key tightly to the table.

Fig. 8. The pantile mould. (Scale 1 in. to the foot.)

Fig. 9. The roll. (Scale 1 in. to the foot.)

Fig. 10. The washing-off table. (Scale ½ in. to the foot.)
a. The washing-off trug.
b. The washing-off frame.
Fig. 11. The washing-off frame. (Scale 1 in. to the foot.)
Fig. 12. The splayer. (Scale 1 in. to the foot.)
Fig. 13. The thwacking frame placed on the thwacking stool. (Scale in. to the foot.)
Fig. 14. The thwacking horse, on which the thwacking frame is placed or thwacking those tiles at the top of the blocks. (Scale ½ in. to the foot.)
a. The table on which the thwacking frame is placed.
b. The place where the thwacker stands to thwack.
c.c. Two wheels to facilitate the moving of the horse from place to place when required.
Fig. 15. The thwacker. (Scale 1 in. to the foot.)
Fig. 16. The thwacking knife. (Scale 1 in. to the foot.) This is imply an iron blade, with a piece cut out exactly to the intended profile f the wing of the pantile, which is trimmed with it immediately after hwacking.

Figs. 17 to 22. The tile kiln.

(N.B. The whole of the furnace and body of the kiln is constructed of fire brick.)
Fig. 17. Plan of the kiln, taken through the body. (Scale 20 feet to the inch.)
h.h. The hatchways.
Fig. 18. Plan of the basement, to the same scale, showing the entrance o the vaults.
Fig. 19.* Section through the centre of the kiln, in the direction of he line *a b*, fig. 18. (Same scale.)
Fig. 20. Section through the centre of the kiln, in the direction of the ine *c d*. (Same scale.)
Fig. 21. Transverse section of the furnaces. (Scale ¼ in. to the foot.) The section marked *a* is taken through the throat of the furnace, on the ine marked *x y*, in fig. 22.
Fig. 22. Longitudinal section of the furnaces. (Same scale.) The rrows in each of the above figures show the direction of the flues.

CHAPTER VII.

ON THE MANUFACTURE OF ENCAUSTIC TILES.

1. The highly-decorative pavements of the mediæval ages, principally to be found in our old ecclesiastical structures, which often shared the fate of many beautiful

* This cut and the following are not quite accurate, the sides of the dome not being straight, as shown in the engraving, but slightly convex.

details of architectural ornament, by being made to gi way to what rustic churchwardens, and others of equ taste and discernment, deemed *improvements*—aft attracting the attention of the antiquary for centurie have at length excited some interest amongst the pra tical minds of these our stirring business times. Abo thirty years since a patent was obtained by Mr. Wright, of the Staffordshire Potteries, for the revival this interesting branch of art, for such it may be tru called. As might have been expected, many difficulti beset the patentee, and for some years nothing was pr duced equal to the old specimens. But still a beginni was made that promised success when skill and capit and a determination to succeed, should be brought bear upon the subject. And these were not long wan ing, as the patent ultimately passed into the hands of gentleman undeterred by difficulties or previous failure and who expressed his intention to make encaustic tile such as would secure the public approbation, even each one cost him a guinea! This is the spirit that h achieved such surprising results in our manufactur generally, within a comparatively brief period; and wonder that in this, as in most other instances, succe has been the satisfactory result. We need scarcely s that the gentleman referred to is Mr. Herbert Minto who, with untiring industry, collected the best spec mens of old tiles that could be found in this country, a by a succession of experiments overcame the obstacl that had retarded the success of the undertaking.

2. The chief of these obstacles was, to discover cla of different colours that could be made to amalgama in such a way as to contract or shrink equally during t processes of drying and firing; and until this was effecte a perfect tile of several colours could not be produce

ındry unsightly cracks appearing on the inlaid parts ' the surface. It will be unnecessary to speak of the ·esent state of perfection to which these beautiful tiles ıve been brought, further than to observe that they ·e yearly becoming more appreciated, both on the score ' durability and ornament; and there can scarcely be a ›ubt that, very soon, no ecclesiastical building, having ıy pretensions to architectural superiority, will be con- ıered to be complete in its decorations without them. y way of information, we may add, that not only ›pies of old tiles are manufactured, but every variety ' design suitable for the character of the building they ·e intended for are supplied. Indeed, almost any ıttern can be produced with facility; and we have seen ›me of the arms of our nobility and gentry so finely :ecuted, that the uninitiated might be pardoned for istaking these inlaid clays for the highly-finished and aborate work of the pencil. In many instances they ıvc been adopted as a substitute for oil-cloth in the ılls and passages of the mansions of our nobility, :ing considered far more beautiful, and, from their ırability, more economical also, in the long run.

3. We will now take a peep into the interior of Messrs. [inton and Co.'s manufactory.* We must first notice, ıat the clays of which the tiles are composed are ob- ,ined in the immediate neighbourhood—the ordinary arl producing a good buff colour when fired; another ınd a warm red; black is produced by staining with anganese; blue with cobalt, &c. W'th the native ays there is a slight admixture of Cornwall stone and ay, and flint from Kent, &c. The whole are subjected › a variety of washings and purifications—the clay in-

* Further details will be found in "Tomlinson's Cyclopædia"— ticle, Pottery and Porcelain.

tended for the surface, especially—and passed throug fine lawn sieves in a liquid, or "slip" state, as it i technically termed. In this state it is conveyed to th slip-kiln, or rather pumped on it, and boiled, until it i in a plastic state, and fit for use.

4. After the modeller has done his part, the patter is cast in plaster in relief, and is then placed in a meta frame of the size required; but it should be stated tha to produce the ordinary 6-in. square tile, it is modelle $6\frac{5}{8}$ in., to allow for shrinkage or contraction, which take place during drying and firing. The maker then com mences his operations. A piece of the fine clay for th surface is flattened out to about a quarter of an inc thick, somewhat after the manner of preparing a pi crust, and this is thrown upon, and pressed upon, th plaster pattern, and receives, of course, a correct indenta tion, or outline of the design. The metal frame containin the plaster mould is divided horizontally, and after th surface is put in, the upper part of the frame is screwe on, and the maker fills up with clay of a somewha coarser description, to form the tile of the requisi thickness. The tile is then put under a screw-press t impart the proper degree of solidity.

5. As far as we have gone, the tile is but of on colour; next comes the task of giving the differe colours required. Suppose a tile be required of thr colours—red, blue, and buff. We will say the surfa piece already put in is of a buff colour. The maker provid himself with vessels of a suitable kind, containing—t one the blue, the other the red colour, in a "slip" stat and these he pours into those parts of the indented surfa that the drawing or finished tile before him tells him be correct. These slips cover the surface entirely, a there is now not the slightest appearance of any patte

r design. After remaining in this state for three days, ntil the water has evaporated for the most part, the rocess of scraping or planing the surface commences, hich is an operation requiring care, though easily ffected by experienced hands. The pattern then makes s appearance, but the colours are scarcely distinguish-ble the one from the other.

6. The tile is then finished as far as the maker is oncerned; and, after remaining in the drying house rom 14 to 21 days, according to circumstances, is con-eyed to the oven, where it is exposed to an intense egree of heat for about 60 hours. After being drawn rom the oven, the tile is finished, except it be that the arties ordering wish the surface glazed, a rapid and asy process, the dipper merely placing the surface in a ub of glaze.

7. Plain self-coloured tiles, such as black, red, choco-ate, buff, &c., and also tesseræ, are made of the same naterial as the encaustic, only that it is dried longer in he kiln, passed through rollers to reduce it to a powder, ind is then finely sifted. Presses of great power, made inder Prosser's patent, make these tiles. The powdered lay is swept into a recess of the proper size, the screw lescends, and, by its immense power, presses the powder nto a solid tile, ready for drying and firing. One man an, with ease, make about 500 per day.

8. *Tesseræ.*—The tesseræ made by Messrs. Minton, inder Mr. Prosser's patent, are now extensively used or mosaic pavements, for which they are admirably idapted. A few words will suffice to explain the nature of the improvements effected in this branch of art by he introduction of the new material.

The mosaic pavements made by the Romans were ormed of small pieces of stone or marble of various

colours, bedded one by one in a layer of cement, each of the pieces being levelled with the others as the work proceeded, and on the completion of the work the unavoidable inequalities of surface were corrected by *rubbing* the whole to a plane surface.

This mode of proceeding was attended with many defects. The irregular shapes of the tesseræ caused the cement joints to be of a thickness that greatly injured the effect of the design, whilst the piecemeal way in which the work was laid rendered it very difficult to produce a level surface.

It is not our purpose here to detail the several attempts that have been made during the last few years, with various degrees of success, to produce mosaic pavements, by the use of clay tesseræ, coloured cements, &c.; but it will readily be understood that the principal difficulties to be overcome in the use of solid tesseræ are those arising from irregularity in the shape and size of the several pieces, as well as the great labour and expense attending the laying of such pavements piece by piece.

These difficulties have been entirely overcome by the use of the patent tesseræ, which, being made in steel dies, by the process above described, are perfectly uniform in size, and fit closely together, with an almost imperceptible joint.

The mode in which the tesseræ are used is precisely the reverse of the Roman process, and is as follows:—a coloured design of the intended mosaic having been drawn to scale, after the fashion of a Berlin wool pattern, the pattern is set out full size on a cement floor, perfectly smooth and level, and on this floor the tesseræ are placed close together, the workmen being guided in the arrangement of the colours by the small drawing.

The pieces are then joined together by a layer of cement applied to the upper surface, and in this way they are formed into slabs of convenient size, which, when hard, are ready for use, and can be laid with as much ease as ordinary flagstones. It will at once be understood, that the side of the slabs which is next the floor during the process of manufacture forms the upper side of the finished pavement, the pattern appearing reversed during its formation.

CHAPTER VIII.

ON THE MANUFACTURE OF BRICKS AND DRAIN PIPES BY MACHINERY.

It is the general opinion that brickmaking by machinery is not economical in small work, since the cost of moulding bears so small a proportion to the total cost. In large engineering works, however, where a contractor requires many millions of bricks in a limited time, for the construction of a tunnel or viaduct, the use of machinery may be desirable. In this chapter we do not, of course, pretend to give descriptions of the various patented and other machines connected with the manufacture of bricks and tiles. Our object, in a work of this kind, being to deal with the principles of the art rather than with a multiplicity of minute details. We may, however, in order to show the great vitality of the trade, quote a few titles of inventions, &c., belonging to the years 1861 and 1862. The patent list displays the strong tendency to invention for making bricks, &c., by machinery. Thus, we have—

Wimball's patent for making bricks, tiles, and drai pipes.

Morrell and Charnley's apparatus for making brick tiles, and other articles from plastic materials.

Green and Wright's machinery for the manufactur of plain and ornamental bricks, slabs, tiles, and quarrie

Basford's patent for constructing brick walls, an ornamenting the materials to be used for the same.

Effertz' machinery for making bricks, tiles, &c.

Grimshaw's patent for compressing brick-earth an other materials.

Morris and Radford's patent for the manufacture o fire bricks, blocks, &c.

Poole's patent for making ornamental bricks, tiles, &c

Newton's machine for making bricks.

Sharp and Balmer's apparatus for the manufactur and drying of bricks.

Grimshaw's patent apparatus, used in drying, pul verising, and compressing clay.

Platt and Richardson's apparatus for making bricks

Foster's method of rendering bricks impervious t damp.

Smith's patent apparatus for the manufacture o bricks, tiles, &c.

The following description of Oates's brickmaking machine is from Tomlinson's "Cyclopædia of Useful Arts, &c." It was described by Mr. J. E. Clift, of Birmingham, at a meeting of the Institution of Mechanical Engineers, in November, 1859, and the description is printed in the "Proceedings" of that body, and is illustrated by four engraved plates, from which Mr. Tomlinson has compiled the illustrative figure. We do not give this machine as the best, since there are many other well-known machines of merit in use; but we

ffer it as an example of the mechanical means adopted n this class of inventions.

The present brickmaking machines at work are livided by Mr. Clift into two classes, viz., those that operate on the clay in a moist and plastic state, and hose for which the material requires to be dried and ground previous to being moulded. In the former class, he plastic column of clay, having been formed into a continuous length by the operation of a screw, pugging blades, or rollers, is divided into bricks by means of wires moved across, either while the clay is at rest or while in motion, by the wires being moved obliquely at an angle to compensate for the speed at which the clay travels. This wire-cutting requires the clay to be soft, so that the bricks are but little harder than those made by hand, and require a similar drying before being placed n the kiln; and all this renders the expense of manufacture about the same as for hand-made bricks. In the second class of machines, the bricks are compressed in a dry state in the mould; but the processes for drying the clay, and reducing it to a uniform powder, add to the cost of manufacture.

Mr. Oates has got rid of both objections, viz., the difficulty respecting the previous preparation of the clay, and the subsequent drying of the bricks. In his machine the clay is used of such a degree of dryness as to allow of its being mixed up and macerated, and compressed nto bricks by a single continuous action, the clay being formed into a continuous column and compressed into the moulds by the action of a revolving vertical screw. The clay requires, in general, no previous preparation beyond that given by the ordinary crushing rollers, and, n some cases, may be put into the machine direct from the pit, unless it contain stones, when it is passed through

a pair of rollers. Figs. 2 and 3, when joined at the parts indicated by the dotted lines, form a longitudinal section of the machine, and fig. 1 is a plan of the screw.

Fig. 1.

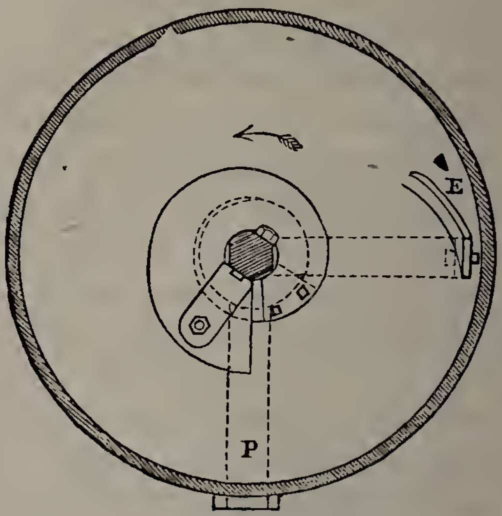
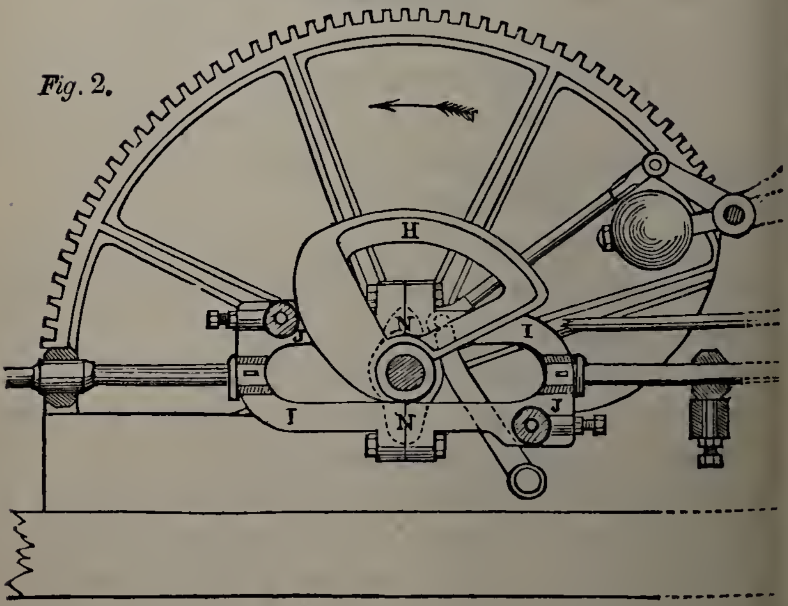
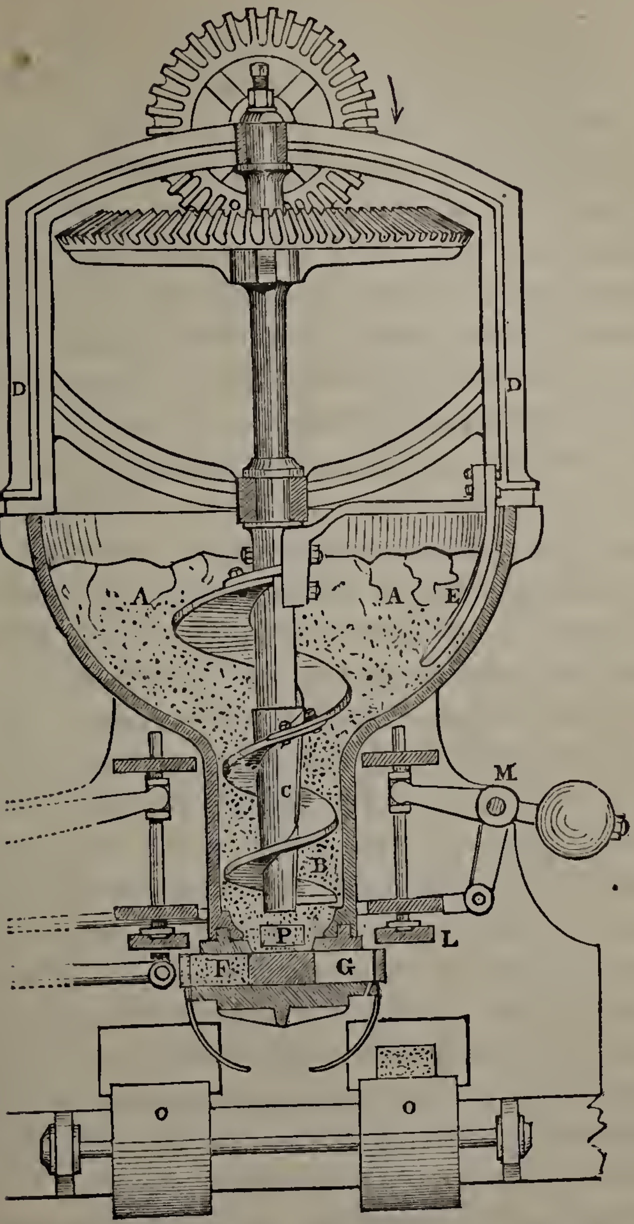


Fig. 2.



The cast-iron clay cylinder A is expanded at the upper part to form a hopper, into which the clay is supplied, and the lower cylindrical portion is about the same in

Fig. 3.



diameter as the length of the brick mould F, at the bottom of the pressing chamber B. The vertical screw C is placed in the axis of the cylinder, and carried by

two bearings in the upper frame D; this screw is parallel at the lower part, the blade nearly filling the parallel portion of the clay cylinder, and is tapered conically at the upper part to nearly double the diameter. When the clay is thrown loosely into the hopper it is divided and directed towards the centre by the curved arm E revolving with the screw shaft, and drawn down by the tapered portion of the screw into the parallel part of the clay cylinder in sufficient quantity to keep this part of the cylinder constantly charged. The clay is then forced downwards by the parallel portion of the screw into the pressing chamber B, and into the brick mould F, which consists of a parallel block equal in thickness to a brick, and sliding between fixed plates above and below, and containing two moulds, F and G, corresponding in length and breadth to the bricks to be made. The mould-block F is made to slide with a reciprocating motion by means of the revolving cam H, which acts upon two rollers in the frame I, connected to the mould-block by a rod sliding through fixed eyes; and the two brick moulds are thus placed alternately under the opening of the pressing chamber B to receive a charge of clay, the mould-block remaining stationary in each position during one quarter of the revolution of the cam H. When the brick mould F is withdrawn from under the pressing chamber, the brick is discharged from the mould by the descent of the piston K, which is of the same dimensions as the brick mould; the piston is pressed down by the lever M, worked by the cam N, when the brick mould stops at the end of its stroke, and is drawn up again before the return motion of the mould begins. A second piston L acts in the same manner upon the second brick mould G, and the discharged bricks are received upon endless bands

O, by which they are brought successively to the front of the machine, when they are removed by boys to the barrows used for conveying them to the kilns to be burnt.

The solid block that divides the two brick moulds F and G is slightly wider than the discharge opening at the bottom of the pressing chamber B, having an over-lap, so that the making of one brick is terminated before that of the next begins, in order to ensure completeness in the moulding. During the instant when this plank is passing the opening at the bottom of the pressing chamber, the discharge of the clay is stopped, and it becomes necessary to provide some means either of relieving the pressure during that period, or of stopping the motion of the pressing screw. Accordingly the pressure is relieved by an ingenious contrivance, forming in effect a safety-valve, which prevents the pressure in the chamber from increasing when the brick mould is shut off, and also serves to maintain a uniform pressure during the formation of the brick, so as to ensure each mould being thoroughly and equally filled with clay; this is effected by an escape-pipe P, similar in form to the brick mould, but extending horizontally from the side of the pressing chamber, and is open at the outer extremity. The regular action of the screw forces the clay into the escape-pipe, as far as its outer extremity, forming a parallel bar of clay in the pipe. The resistance caused by the friction of this bar in sliding through the pipe is then the measure of the amount of pressure in the machine; and this pressure cannot be exceeded in the machine, for the instant that the brick mould is full, the further supply of clay, fed into the pressing chamber by the continuous motion of the screw, escapes laterally, by pushing outwards the column of clay in the escape-pipe. The uniform pres-

sure of every brick in the mould up to this fixed limi is ensured by the escape-pipe not beginning to act unti that limit of pressure is reached. Its action is simila to that of a safety-valve, and the amount of pressur under which the bricks are made is directly regulate by adjusting the length of the escape-pipe. The latte discharges a continuous bar of solid clay, advancing b intermittent steps of $\frac{1}{4}$ to $\frac{1}{2}$ in. in length, each tim that the brick mould is shut off and changed. Th projecting piece of clay from the end of the escape-pip is broken off from time to time, and thrown back int the hopper of the machine.

The upper side of the solid block separating the tw moulds F and G is faced with steel: and the uppe face of the brick is smoothed by being sheared off b the edge of the opening in the pressing chamber; th under face of the brick is smoothed by being planed b a steel bar R, fixed along the edge of the under plate and having a groove in it for discharging the shavin of clay taken off the brick.

The screw shaft is driven by bevil gear from the shaf S, which is driven by a strap from the engine, the spee being adjusted according to the quality of the clay o the wear of the screw. The screw is driven at abou thirty revolutions per minute, when at full speed, or on brick for each revolution of the screw. The machin completes 12,000 bricks per day, or an average c twenty per minute. The clay, as already stated, ca be taken direct from the pit, passed through crushin rollers, and then fed straight into the moulding machine Indeed, the clay within a quarter of an hour after bein brought from the pit may be seen stacked in kilns, an in a few days burnt ready for use. The amount c power required for driving the machine, and the wea

of the screw, vary according to the material worked. With a calcareous marl about twelve horse-power was found sufficient. When the material is very siliceous the cast-iron screws wear out quickly. Gun-metal has been found much more durable than iron for the screw and mould-block.

In burning bricks that contain much alumina, and consequently retain a good deal of moisture, it is found advisable to stack the bricks in the kiln in *lifts* of from fifteen to twenty courses each. As soon as the bottom lift has been stacked, small fires are lighted to drive off the steam from the bricks, which might otherwise soften those stacked above; the middle lift is then stacked and similarly dried, and then the top lift; after which the full fires are lighted.

The crushing strength of these bricks made in the machines at Oldbury is said to be double that of the hand-made blue bricks of the neighbourhood, being an average of 150 tons compared with 76 tons, or 8,024 lbs. per square inch compared with 4,203 lbs. The transverse strength, with 7 in. length between the bearings, was found to be, for hand-made bricks, 2,350 lbs., for machine-made bricks, 3,085 lbs., and for the same, hard burnt, 4,320 lbs.

One of the advantages of this machine is, that clay containing a good deal of stone, which could scarcely be worked for hand-made bricks, can be used. The brick-earth at Cobham is very unfavourable for brick-making, it being so weak and friable that hand-made bricks made from it were crushed by a moderate pressure; when made by the machine, however, serviceable bricks were turned out. A material containing 84 per cent. of silica has been made by this machine into bricks. The bricks had not any hollow or *frog* in the

upper space for holding the mortar, but arrangements were being made for producing it.

The extent to which bricks absorb water is important, since dry houses cannot be built with bricks that are very absorbent. A brick of 9 lbs. weight will absorb about 1 lb. of water, and it is stated that the bricks made by this machine absorb less.

The cost of Oates's machine is from £150 to £200, exclusive of the engine for driving it. The cost of brick-making varies according to the price of coal in different localities; but there is very little variation in the price of the unburnt bricks made by the machine, the difference arising chiefly from the varying amount of royalty charged on the clay in the pit, which varies from 1*s.* to 2*s.* 6*d.* per 1,000. A machine at Cobham, employed by Messrs. Peto and Betts, produced 200,000 bricks in a fortnight of eleven days, but the average number per week, of five and a half days, was considered to be 80,000, or at the rate of twenty-four bricks per minute. The contract for the bricks in and out of the kilns, exclusive of the cost of the coals, was first taken at 5*s.* 9*d.* per 1,000 bricks; which was afterwards raised to 6*s.* 9*d.*, owing to the distance of the clay from the machine. To this had to be added 6*d.* per 1,000 royalty, and the wages of the engine-driver at 6*d.* per 1,000, raising the expenses to 7*s.* 9*d.* per 1,000 bricks. The quantity of coals required for burning the bricks, and for the engine driving, might safely be taken at ½ ton per 1,000; and the price of coal at that place being 25*s.* per ton, the total cost of making the bricks by the machine amounted to 20*s.* per 1,000, including the burning.

The following particulars respecting drain-pipe making machines, and hollow bricks, are also from Mr. Tomlinson's "Cyclopædia."

The large and increasing demand for draining tiles and pipes has led to great economy in their manufacture. Some are moulded flat, and afterwards bent round a wooden core to the proper shape: others are made at once of a curved form by forcing the clay through a *dod* or mould, fig. 4, by mechanical pressure. The action will be readily understood from fig. 5, which represents a section of a strong iron cylinder, containing a quantity of clay in the act of being pressed down with enormous force by a solid piston or plunger. The clay, as it escapes through the dod, is evidently moulded into the form of the pipe (also shown in section), which is cut off in lengths, by means of a wire, and these, after a preliminary drying, are ready for firing. By using dods of different sizes, pipes of various magnitudes are formed.

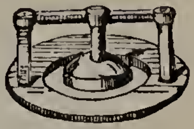


Fig. 4.

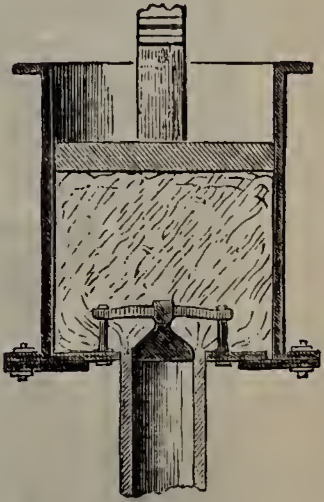
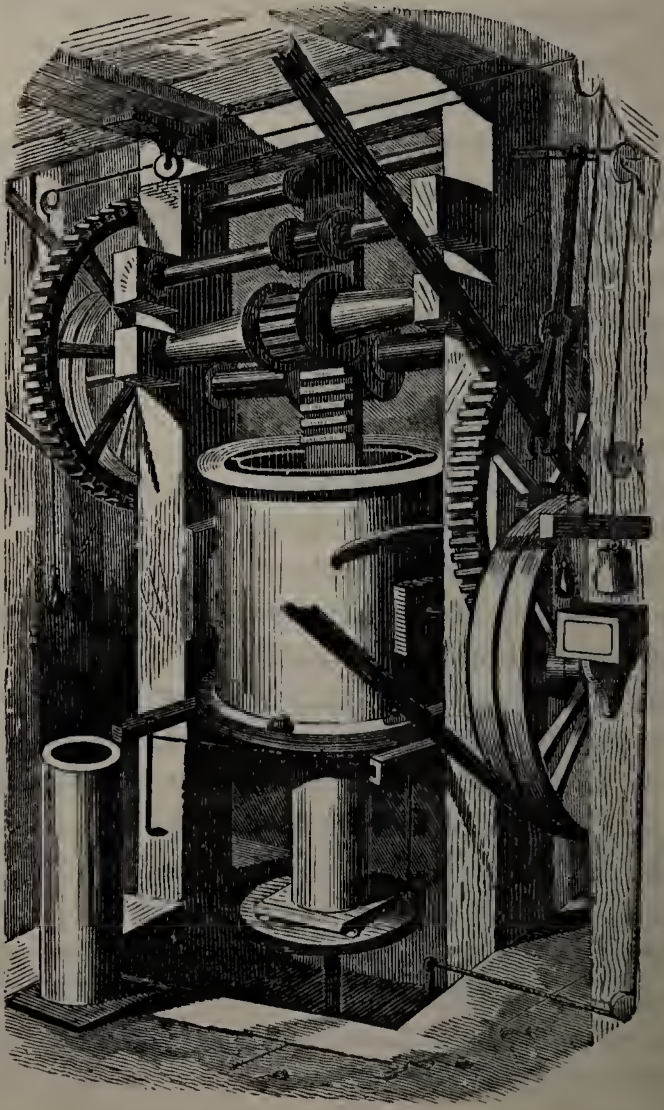


Fig. 5.

Fig. 6 is an elevation of a drain-pipe making machine, which we have copied from Mr. Green's works at Lambeth. The cylinder contains a second cylinder, capable of holding a given weight of clay, adapted to the moulding of a certain number of pipes at one charge. Thus, one *box-full* will furnish five 9-in. pipes, six 6-in. pipes, seven 4-in. pipes, and so on. By the action of the rack the piston forces the clay through the dod or die upon a table, so balanced by weights that the lengthening pipe is sufficient by its weight to force down the table, and when a certain length of pipe

is formed, the boy stops the machine by shifting the strap which drives the rack-screw from the fast to the loose pulley, and then cuts off the length of pipe with

Fig. 6.



a wire, removes the pipe so formed, raises up the table, sets the machine in action, and receives a pipe upon the

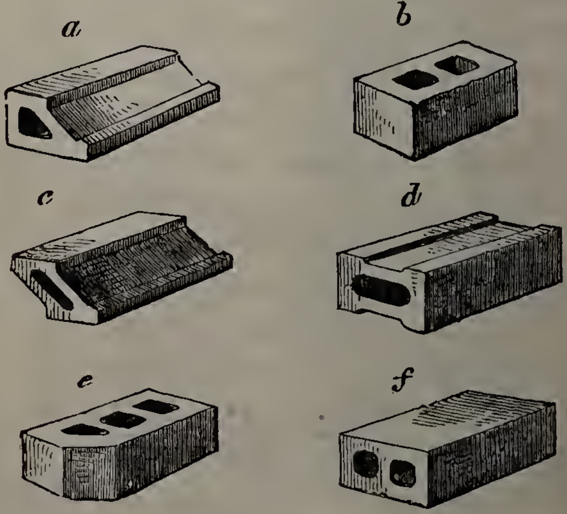
table as before. When all the clay is thus forced out of the cylinder, the action of the rack is reversed, whereby the plunger is drawn up out of the cylinder. The cylinder, which moves on a kind of hinge, is then tilted on one side to receive its charge of clay, and being restored to its vertical position, the action proceeds as before. By an ingenious contrivance, the fork which shifts the strap from the fast to the loose pulley, is weighted in such a manner that, when the boy raises his foot from a treadle, the strap is at once moved on to the loose pulley, and *vice versâ*, thus giving the attendant a third hand, and diminishing the chances of danger from the strap. Mr. Green has a machine worked by a screw, in which the process is continuous. These pipes are washed with glaze before the firing, as will be explained hereafter.

By means of a tile machine, the *hollow bricks* are formed, which are so much recommended by the "Society for Improving the Condition of the Labouring Classes," and introduced by them in the construction of dwelling-houses for the poor. The idea of tubular bricks is not new, for such articles were used by the Romans in large vaultings, where lightness of construction was required, and they are said to be in common use in Tunis at the present time. The size of the bricks is 12 in. long, and three courses rise 1 ft. in height. Nine hollow bricks will do as much walling as sixteen of the common sort, with only a slight increase in weight. In passing through the tile machine, or in the process of drying, the bricks can be splayed at the ends for gables, or marked for closures, and broken off as required in use, or they may be perforated for the purpose of ventilation. If nicked with a sharp-pointed hammer, they will break off at any desired line; and the angles may

be taken off with a trowel as in the common brick. The bricks for the quoins and jambs may be made solid or perforated, and with perpendicular holes, either circular, square, or octagonal: those in the quoins may be so arranged as to serve for ventilating shafts. The hollow bricks, from their mode of manufacture, are more compressed than common bricks, require less drying, and are better burned with less fuel.

The following figures represent some of the forms of hollow bricks in common use. *a*, fig. 7, is an *external* brick, $11\frac{3}{4}$ in. long, which with the *quoin* brick *e*, and the *jamb* brick *b*, are sufficient for building 9-in. walls. *e* is $10\frac{1}{4}$ in. long, with one splayed corner for forming external angles, reveals, and jambs of doors and windows, either square or splayed. The *internal jamb* and *chimney* brick, *b*, is $8\frac{3}{4}$ in. long; *c* is an

Fig. 7.



internal brick, adapted to any thickness of wall beyond 9 in.: *d* is for $5\frac{3}{4}$-in. partitions, or internal walls, and arch bricks, and is used for floor and roof arches of 7 to 10 ft. span. *f* is used for the same purpose, with

a webb to give extra strength, and to adapt them for using on edges in partitions, $3\frac{3}{4}$ in. thick to rise in 6-in. courses.

Fig. 8 represents a specimen of hollow brick work in 6-in. courses, with square rebated joints for extra strength. These bricks are adapted to the lining of flint or concrete walls. Fig. 9 is a section illustrative of the construction adopted in H. R. H. Prince Albert's model houses. The span of the arches is increased over the living rooms to 10 ft. 4 in., with a proportionate addition to their rise. The external springers are of cast-iron, connected by wrought-iron tie rods.

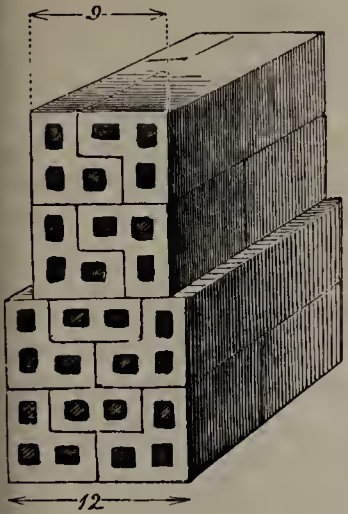
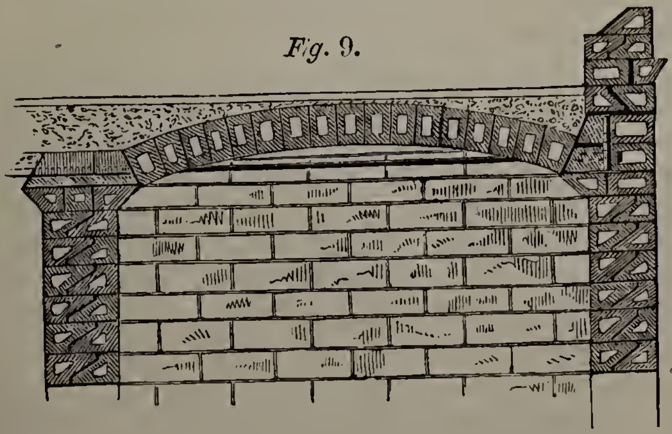


Fig. 8.

It is stated that there is an advantage of 29 per cent. in favour of the patent bonded hollow bricks over ordi-

Fig. 9.



nary bricks, in addition to a considerable diminution in the cost of carriage or transport, and of 25 per cent. on the mortar and the labour.

APPENDIX.

The following paper was read by Mr. Tomlinson at a meeting of the Geologists' Association, on February 3, 1862:—

On the Plasticity and Odour of Clay.

It is a happy result of Bacon's method of inquiry that science is not required to explain the causes of things, but to state the laws of phenomena. Nevertheless, while these laws are obscure, and facts are scattered, theory may often do good service by collecting and marshalling them: for, as our great master of induction well observes, "Facts are the soldiers, but theory is the general." And again, "Truth is more easily evolved from error than from confusion." That is, a bad theory is better than none at all, for it serves to collect and arrange the facts, and thus makes them more easy to handle.

In these remarks must be found my excuse to-night for endeavouring to bind together some of the facts respecting a property of a very common substance; namely, the Plasticity of Clay.

The more I consider this property the more wonderful and inexplicable does it appear. Take a mass of dry clay; it cracks easily, and crumbles readily: add to it a certain proportion of water, and it becomes *plastic*—it obeys the will of the artist or the artizan, who can, out of this yielding mass, *create* new forms, or perpetuate old ones. Drive off the water at a red heat, and plasticity is for ever lost; *rigidity* takes its place: the clay is no longer clay, but something else. It may be reduced to powder, and ground up with water; but no art or science can again confer upon it its plasticity.

All this is very wonderful. There is another fact that is equally so: if we combine the constituents of clay in the proportions indicated by the analysis of some pure type of that substance, we fail to produce plasticity. I have on the table specimens of Dorset clays dry and crumbling; the same wet and plastic; and the same in the forms of casts of fossils, which have been passed through the fire,

and have exchanged plasticity for rigidity. They are, in fact, in the form of *biscuit*.

With respect to the temperature at which clay becomes rigid, we have no accurate information. It is much lower than is generally supposed, as will appear from the following experiment:—I pounded and sifted some dry Dorset clay, and exposed it to a sand-bath heat in three portions varying from about 300° to 600°. Specimens were taken out from time to time, and rubbed up with water, but they did not lose their plasticity. Some clay was put into a test tubc with a small quantity of mercury, and heated until the mercury began to boil. At this temperature (viz. 650°) the clay did not cease to bc plastic. The flame of a spirit-lamp was applied, and the tube was heated below redness; after which the clay, on being mixed with water, showed no sign of plasticity.

In experiments of this kind, the first action of the heat is to drive off the hygrometric water. The clay then becomes dry, but is not chemically changed; it does not cease to be plastic. On continuing to raise the temperature, the chemically combined water is separated, and the clay undergoes a molecular change, which prevents it from taking up water again, except mechanically. With the loss of this chemically combined water, clay ceases to be plastic.

It was, I believe, first noticed by Brongniart,* that we cannot produce plasticity by the synthesis of clay. The fire clay of Stourbridge, for example, is a hydrated silicate of alumina, represented by the formula $Al_2\,O_3$, $2\,Si\,O_2 + 2\,Aq$. If we mix one atom of the sesquioxide of alumina with 2 atoms of silica and 2 of water, we get a compound which cannot be called clay, since it is wanting in plasticity.

It is quite easy to obtain either alumina or silica in the gelatinous state; but we cannot obtain them in the plastic state.

Clay is almost the only substance in the mineral kingdom that possesses plasticity. In loam, if the sand be in large proportion, and in marl, if calcareous matters abound, so as to deprive either material of plasticity, it ceases to be clay. There are also certain silicates of alumina which are not plastic; such as bole, lithomarge, and fullers'-earth. Bole consists chiefly of a hydrated bisilicate of alumina, in which a portion of the alumina is replaced by sesquioxide of iron. Lithomarge also contains iron, and is sometimes so compact as to be used for slate-pencils. Fullers'-earth contains lime, magnesia, and iron, in addition to its principal ingredients.

* "Traité des Arts Céramiques." Paris, 1844. Vol. i. p. 82.

There is probably no substance so indeterminate in its composition as clay. Regarding it, as Lyell does,* as "nothing more than mud derived from the decomposition of wearing down of rocks," it must necessarily contain a variety of substances; such as oxide of iron, lime, magnesia, potash, silica, bitumen, fragments of undecomposed rock, &c. These substances impair the plasticity of the clay, and impress upon it certain characters which are of more importance to the manufacturer than to the chemist, or the geologist. Brongniart† enumerates, and gives the analyses of no fewer than 167 clays and 28 kaolins, all of which are in use in the arts in different parts of the world. They probably all differ in plasticity, but they all possess it; and at a high temperature exchange it for rigidity. A rough method of measuring the plasticity of different clays is to note the length to which a cylinder of each can be drawn out in a vertical direction without breaking. In such a comparison, the clays must, of course, be worked equally fine, and contain the same proportion of water.

It is commonly stated that the ingredient that confers plasticity on clay is its alumina; and yet, strange to say, pure alumina alone whether gelatinous, or after having been dried and ground up with water for a long time, never gives a plastic paste. Indeed, nothing can be conceived less plastic than gelatinous alumina, as may be seen from the specimens on the table. We may drive off most of the water from this gelatinous hydrate, but it will not become plastic. Or we may form clay by mingling solutions of the silicate of alumina and the aluminate of potash. You see they are perfectly fluid. I apply the heat of a spirit-lamp, and we get an opalescent gelatinous mass, but still no plasticity. We have, indeed, formed a gelatinous clay.

We cannot say that the gelatinous state of alumina is the cause of plasticity in clay; for silica may be made as gelatinous as alumina and silica is certainly not the cause of plasticity. It may be that the strong affinity of alumina for water (retaining a portion of it even when near a red heat) may be the cause of this property—just as turpentine renders wax plastic; and water and gluten confer the same property on starch.

We have seen that clay ceases to be plastic when its chemically combined water has been driven off. Still, however, water cannot be said to be the cause of plasticity, as a general property, since we have, in melted glass, a more perfect example of plasticity even tha

* "Manual of Elementary Geology" (1855), p. 11.
† "Des Arts Céramiques," Atlas of Plates.

in clay; and few substances are more plastic than sealing-wax at a certain temperature.

A clear idea of plasticity, and of some of the other mechanical properties of matter, may probably be gained by considering them as variations of the forces of cohesion and adhesion, and by bringing these, in their turn, under Newton's great law of attraction, which, whether exerted between atoms or masses, is directly as the mass, and inversely as the squares of the distances.

Now, if we suppose the distances between the molecules of matter to be 1-millionth or billionth, or 2, 3, 4, 5, 6, &c., millionths or billionths of an inch asunder, the intensity of their attractions will be 1, $\frac{1}{4}$th, $\frac{1}{9}$th, $\frac{1}{16}$th, &c., or, to represent it in a tabular form :—

Distances	1	2	3	4	5	6	7	8	9	10,	&c.
Intensities of attraction	1	$\frac{1}{4}$	$\frac{1}{9}$	$\frac{1}{16}$	$\frac{1}{25}$	$\frac{1}{36}$	$\frac{1}{49}$	$\frac{1}{64}$	$\frac{1}{81}$	$\frac{1}{100}$,	&c.

Suppose the molecules to be of the same density, but at different distances apart, as represented in the upper line. At the distance of 1-millionth of an inch we get an intensity of attraction represented by 1. At 2-millionths of an inch the force of attraction is only one-fourth. Now, the idea is this, that the mechanical properties of matter,—such as porosity, tenacity, hardness, brittleness, plasticity, elasticity, &c., depend upon variations in the attractive force of the molecules according to the distances apart of such molecules. Thus, if the molecules of clay require to be 5-millionths of an inch apart in order to produce plasticity, the intensity of attraction between them will be represented by $\frac{1}{25}$th; but if such clay be passed through the fire, and the molecules, in consequence of the escape of water, be brought nearer together, and rigidly fixed at 4-millionths of an inch asunder, the force of attraction will then be $\frac{1}{16}$th.

Now, the method of arranging the particles of clay at that precise distance that shall impart plasticity, is one of Nature's secrets that we have not yet succeeded in penetrating. It may be that the circumstances under which clay is formed and deposited, or the time that has elapsed since its formation, or the pressure of the superposed layers, may have so arranged the particles as to enable them to become plastic when the proper proportion of water is added. It may be that a certain state of disintegration is required on the part of the alumina and the silica, so that their proximate elements shall be neither too fine nor too coarse; or it may be that the silica, in combining with the alumina, separates the atoms of the latter to precisely those distances required for the development of the property;

or, lastly, the presence of a small portion of animal or other organic matter in clay may have something to do with this remarkable property.

An extensive series of experiments, by Delesse,* show the presence of animal matter in quartz and various rocks, where its presence had not previously been suspected; and this may have as important an effect in modifying the properties of a mineral as the presence of minute portions of bodies, formerly entered as impurities, has in producing pseudo morphous crystals.

Still, the question recurs, Why is not a clay artificially formed from pure materials plastic? The answer is, that we do not know all the conditions of plasticity. We *do* know the conditions under which some mechanical properties exist—such as the hardness of steel, the brittleness of unannealed glass—and can confer or remove such properties at pleasure. But with respect to plasticity, we can only confer a factitious property of this kind on mineral substances by taking advantage of another property which it somewhat resembles, namely, *viscosity* or *viscidity*. Viscosity differs in plasticity in this, that the viscous body does not retain the form impressed upon it when the force is removed, as a plastic body does. The materials of the old soft porcelain of Sèvres had no plasticity; but this property was conferred by means of soft soap and parchment size.†

Without speculating further on the nature of plasticity, I may remark that in the ancient philosophy the word was one of power. Derived from the Greek πλασσειν, or πλαττειν, "to form," or "to create," it not only included the arts of modelling in clay, but also sculpture and painting, and, by a refinement of language, poetry and music. Plato and Aristotle even supposed that a plastic virtue resided in the earth, or did so originally, by virtue of which it put forth plants, &c.; and that animals and men were but effects of this plastic power. They did not suppose the world to have been made with labour and difficulty, as an architect builds a house; but that a certain "efficient nature" (*natura effectrix*) inherent and residing in matter itself, disposed and tempered it, and from it constructed th

* "De l'azote et des matières organiques dans l'ecorce terrestre."—*Annales d Mines*, xviii., 1860.

† Brongniart ("Des Arts Céramiques") says that the old *porcelaines tendres* we formed of 22 per cent. of fused nitre, 60 of Fontainebleau sand, 7·2 of salt, 3·6 of alun 3·6 of soda, and 3·6 of gypsum. These materials were fritted and ground, and parts taken, to which were added white chalk 17 parts, marl 8. This mixture w ground, sifted very fine, and made up into a paste with 1-8th soft soap and size, or, a later period, with gum tragacanth.

whole world. Aristotle distinctly recognises *mind* as the principal and directing cause, and *natura* as a subservient or executive instrument. Even in later times men have contended for the existence of a plastic nature, or incorporeal substance endowed with a vegetative life; but not with sensation or thought, penetrating the whole universe, and producing those phenomena of matter which could not be solved by mechanical laws. The learned Cudworth supports this view,* and the discussions into which it led him and other metaphysicians form a curious chapter in the history of the human mind. In England we do not now retain the term *plasticity*, except as a physical property of matter; † but in Germany it has still an extensive figurative meaning. The word *plastisch* still means *bildend* or *schöpferisch* (i.e. "creative"); and it is still applied not only to sculpture, but also to painting, poetry, and music. A German well understands the expression "plastische Gedanken," or "plastic thoughts."

Before concluding, I would refer to another property of clay, which seems to me as wonderful as its plasticity; namely, its *odour* when breathed on, or when a shower of rain first begins to wet a dry clayey soil. This odour is commonly referred to alumina, and yet, strange to say, pure alumina gives off no odour when breathed on or wetted. The fact is, the peculiar odour referred to belongs only to impure clays, and chiefly to those that contain oxide of iron. This was pointed out by Brongniart as far back as 1816,‡ who also remarked hat minerals which do not contain alumina, such as pulverised chalcedony, possess this remarkable property.

I have found that a pure kaolin, ground up in a mortar with a mall quantity of water, emits a slight odour, which, however, ecomes much more sensible if a little sesquioxide of iron be dded.

Smooth quartz pebbles when rubbed together give an electric spark, nd a fetid odour. It is commonly supposed that sea-side pebbles lone possess this property; but the odour belongs equally to those ound among gravel overlying the chalk, and in ploughed lands where he surface is exposed to all the vicissitudes of the weather. It is quite ossible that the odour of these pebbles may hereafter be traced to he presence of organic matter; but I cannot resist the reproduction ere of a suggestive hint given me by my friend Professor Bloxam,

* See "The True Intellectual System of the Universe," by Ralph Cudworth, D.D., 78. A reprint has been published by Tegg, in which see Vol. I., p. 226, *et seq.*

† Dr. Johnson defines *plastic* as "having the power to give form."

‡ "Dictionnaire des Sciences Naturelles," art. *Argile.*

who is reminded by the spark and odour from these pebbles of the presence of ozone.

What, again, is the cause of the odour in the narrow parts of stone buildings, not of new buildings alone, but of old ones, as in the staircases of old cathedrals?

I do not attempt to reply to these questions. It requires some amount of knowledge and experience to put them—but how much more to answer them!

On Drying Bricks.

(*Extracted from Noble's "Professional Practice of Architects," p.* 143.)

"The observations by Richard Neve, above a century since, upo[n] *stock bricks*, will illustrate the subject: 'When the *hack* is as high a[s] they think fit, they *cover them with straw* till they are dry enough t[o] burn,' &c., &c. He proceeds: 'A brickmaker being sent to Rum[-] ford, in Essex, went to work unadvisedly, and laid them *abroad* in [a] place to dry; but the sun, about ten o'clock, began to shine very ho[t] and the whole quantity of bricks *burst to pieces*, so that he was force[d] to go to work again: and then, before the sun shone too hot, [he] thatched or covered them over with straw till the next mornin[g;] when removing it, they did very well when set on the hack; a[nd] when burnt, were curious *red bricks*, which would ring when hit wi[th] any hard thing.'"

On the use of Coal Dust in making Clamp Bricks.

(*Extracted from Noble's "Professional Practice of Architects," p.* 15[7].)

"Natives should be employed (*in making bricks in Wales*) in t[he] manufacture, in preference to London hands, as the former use c[oal] dust in preparing the earth, and not breeze (ashes), as about Londo[n;] and provided an undue portion of coal is used, a whole *clamp* wo[uld] be destroyed, of which there was an instance at Lampeter (Cardig[an-] shire). An Islington brickmaker was sent to Wales, and as he [was] too conceited to make inquiries, or to receive information, set li[ght] to a *clamp* he had prepared with coal, being 70,700; and in a v[ery] short time the whole kiln was in one general blaze. The man be[ing] alarmed, took to his heels, and, unlike Lot's wife, he turned [not] back, neither looked behind him. Even from the heights leading [to] Landovery the *reflection* was quite enough for him; nor did he s

till he reached London, being, as he said, '*afearèd*' they would catch him and put him in prison!"

Brickmaking at Great Grimsby, Lincolnshire.

Large quantities of bricks have been made during the last few years at Great Grimsby, for the Dock Company, from the Humber silt. These bricks are remarkable for their colour, which varies in the same brick from dark purple to dirty white, passing through various shades of blue, red, and yellow, in the space of two or three inches. The silt, when first dug out of the bed of the Humber, is of a dark blue colour, which soon, from exposure to the air, changes to a brown.

The bricks made for the Dock Company were burnt in close clamps—fired with layers of small coal, but without coal-dust or ashes being mixed with the clay as in London brickmaking. With the first clamps there was much waste, the quantity of fuel being excessive, and the bricks were cracked and made brittle in consequence; but the experience obtained by the first trials has led to the production of a sound well-burnt brick, with, however, the peculiar colour above mentioned.

Considerable quantities of bricks have been lately made for sale at Great Grimsby, and burnt in clamps with flues, as in kiln burning, which method appears to be attended with less waste than close clamping.

The *slack* or small coal used for fuel may cost from 2*s*. 6*d*. to 4*s*. per 1,000 bricks. The cost of clay getting, tempering, moulding, and drying, is about 8*s*. 6*d*. per 1,000. The moulds used are of wood, plated with iron. The process employed is that known as slop-moulding.

Kilns as well as clamps are used in this part of Lincolnshire, their construction being similar to that of the kilns in general use in the Midland Counties.

Brickmaking in Suffolk.

Two kinds of bricks are made in Suffolk, viz., reds and whites. The latter are much esteemed for their shape and colour, and large quantities are annually sent to London, for facing buildings of a superior class.

Clay.—The supplies of brick-earth are chiefly derived from the plastic clays lying above the chalk, although the blue clay is occasionally used.

The clays in most parts are too strong to be used as they rise, and have consequently to be mixed with a white loam or a milder earth.

Tempering.—The clay is turned over in February and March, and in some parts of Suffolk it is passed through the wash-mill, but this is not generally the case.

Tempering is generally performed by spade labour, but the pug-mill is sometimes used, although not commonly, for white bricks; it is, however, used for all other white ware.

Moulding.—*The brick mould* is of wood, shod with iron; the dimensions vary slightly according to the nature of the clay, but are usually as follows: $9\frac{7}{8}$ths long by $4\frac{15}{16}$ths wide and $3\frac{1}{4}$ deep. There is no hollow formed in the bottom of the brick for the mortar joint. Brass moulds are unknown.

Sea sand is used in the process of moulding, for sanding the mould and the table.

The strike is used for taking off the superfluous clay from the mould. The use of the plane is not known.

Drying.—The bricks are not dried on flats as in the Midland Counties, but are taken directly from the moulding stool to the hacks. Sheds are used in some yards, and drying houses with flued floors are used in winter for pantiles and kiln tiles, but not for bricks.

The length of a hack is about 70 yards, and each moulder will keep four hacks going.

The *time* required for drying in the hacks of course varies according to the weather, but may be stated on an average at about eighteen days for red bricks. White bricks dry somewhat quicker.

The *contraction* of the clay in drying amounts to about $\frac{7}{8}$ in. in the length of a brick, and, if properly burnt, the shrinkage in the kiln is imperceptible.

The *weight* of a brick, when first moulded, is about 8 lbs.; when dried, about 7 lbs.; and when burnt, about 6 lbs.; but much depends upon the nature of the earth.

Burning.—*The construction of the kiln* is quite different from that of the kilns used in other parts of England, having two arched

furnaces running its whole length underneath the floor, which is formed of a kind of lattice work, through the openings of which the heat ascends from the furnaces below.

The cost of erecting a kiln to burn 50,000 whites is about £145. A kiln to burn 35,000 reds costs about £100.

The bricks are commonly set in the kiln in bolts two bricks long by ten on; but some brickmakers prefer to cross them in the alternate courses, in order to admit the heat more freely.

The *fuel* used is coal, and the quantity consumed is about half a ton per 1,000 for white, and 7 cwt. per 1,000 for red, bricks.

The *time of burning* is about 60 hours for white, and 40 hours for red, bricks; white bricks requiring a greater heat than the red ones to bring them to their proper colour. The coal costs from 15*s.* to 16*s.* per ton.

*Cost of Manufacture.**

The selling prices vary from £1 10*s.* to £2 per 1,000 for reds, and from £2 2*s.* to £3 per 1,000 for whites.

Of red bricks two qualities only are distinguished, viz., outside and inside; of white, four qualities are distinguished, viz., best, 2nd, 3rd, and murrays.

The price of the ordinary red brick is about £1 10*s.* per 1,000, and the cost may be thus divided:—

	£	*s.*	*d.*
Clay digging, per 1,000	0	2	6
Tempering, ditto	0	1	0
Moulding, ditto	0	5	0
Drying, ditto	0	0	6
Barrowing from hacks and setting kiln ditto .	0	1	0
Burning, ditto	0	1	3
Drawing kiln, ditto	0	0	8
Stacking, ditto	0	0	3
Cost of labour per 1,000	£0	12	2
Coals, about	0	6	0
Duty	0	6	1½
Rent, tools, contingencies, and profit . .	0	5	8½
Selling price at the yard, about	£1	10	0

* These estimates belong to the date of the First Edition of this work.

White bricks are made in many parts of England, but the Suffolk whites have the pre-eminence over all others.

The white bricks made near Lincoln are remarkable for *swelling* when laid in work, which causes them to throw off the mortar joints, and renders it impossible to make use of them in good work.

The clay from which these bricks are made extends from the Witham northwards as far as the Humber, and, so far as we are aware, possesses the same property throughout this distance, the bricks made from it at various points between the Witham and the Humber having the common defect of swelling after burning. A curious specimen of this may be seen in a large chimney at Saxilby, which has a complete twist, from the irregular swelling of the brick-work.

The peculiar property of swelling after burning is not confined to the Lincolnshire white clay. The author was informed some years ago, by Mr. Vignoles, C.E., that some of the bricks made on the Midland Counties Line of Railway, between Rugby and Derby, had the same defect.

For the above particulars respecting the Lincolnshire white bricks we are indebted to Mr. William Kirk, of Sleaford.

On the Making and Burning of Drain Tiles.

Extracts from a communication by Mr. Law Hodges, published in the Journal of the Royal Agricultural Society of England, Vol. V. Part II. :—

"Reflecting on these obstacles to universal drainage, where required, I conferred with Mr. John Hatcher (brick and tile maker, and potter, Benenden, Kent), on the possibility of erecting a kiln of common clay that would be effectual for burning these tiles, and of cheap construction—and the result was the building one in my brickyard in July last, and the constant use of it until the wet weather at the commencement of this winter compelled its discontinuance, but not until it had burnt nearly 80,000 excellent tiles; and in the ensuing spring it will be again in regular use.

"I shall now proceed to take in order the six points enumerated under the 9th head of the Prize Essays for 1845, as printed in the last volume of the Royal Agricultural Society's Journal, viz. :—

"1st. Mode of working clay according to its quality.
"2nd. Machine for making tiles.
"3rd. Sheds for drying tiles.
"4th. Construction of kilns.
"5th. Cost of forming the establishment.
"6th. Cost of tiles when ready for sale.

"1st Point. Working the clay.

"All clay intended for working next season must be dug in the winter, and the earlier the better, so as to expose it as much as possible to frost and snow. Care must be taken, if there are small stones in it, to dig it in small pits, and cast out the stones as much as possible, and also to well mix the top and bottom of the bed of clay together. It is almost impossible to give minute directions as to mixing clay with loam, or with marl when necessary, for the better working it afterwards, as the difference of the clays in purity and tenacity is such as to require distinct management in this respect in various localities; but all the clay dug for tile-making will require to be wheeled to the place where the pug-mill is to work it; it must be there well turned and mixed in the spring, and properly wetted, and finally spatted down and smoothed by the spade, and the whole heap well covered with litter to keep it moist and fit for use through the ensuing season of tile-making.

"2nd Point. Machine for making tiles.

"For the reasons already alluded to, I prefer Hatcher's machine. Its simplicity of construction, and the small amount of hand labour required to work it, would alone recommend it; for one man and three boys will turn out nearly 11,000 pipe tiles of 1 in. bore in a day of ten hours, and so in proportion for pipes of a larger diameter; but it has the great advantage of being movable, and those who work it draw it along the shed in which the tiles are deposited for drying, previously to their being burnt: thus each tile is handled only once, for it is taken off the machine by the little boys who stand on each side, and at once placed in the rows on either side of the drying shed, thus rendering the use of shelves in the sheds wholly unnecessary, for the tiles soon acquire a solidity to bear row upon row of tiles, till they reach the roof of the sheds on either side; and they dry without warping or losing their shape in any way.

"The price of this machine is £25, and it may be proper to add, that the machine makes the very best roofing tiles that can be made, and at less than half the price of those made by hand, as well as

being much lighter, and closer, and straighter, in consequence of the pressure through the die.

"It is necessary, in order to ensure the due mixing of the clay, as well as to form it into the exact shape to fill the cylinders of the machine, to have a pug-mill. Messrs. Cottam and Hallen make these also, and charge £10 for them. This mill must be worked by a horse; in general one day's work at the mill will furnish rather more prepared clay than the machine will turn into tiles in two days

"3rd Point. Sheds for drying.

"The sheds necessary for this system of tile-making will be of a temporary kind: strong hurdles pitched firmly in the ground in two parallel straight lines, 7 ft. apart, will form the sides of the sheds and the roof will be formed also of hurdles placed endways and tied together at the top, as well as to the upper slit of the hurdle, with strong tarred twine, forming the ridge of the roof exactly over the middle of the shed. They must then be lightly thatched with straw or heath, and the sharpness of this roof will effectually protect the tiles from rain. Two of these sheds, each 110 ft. long, will keep one of the kilns hereafter described in full work.

"N.B.—These sheds should be so built as to have one end close to the pug-mill and the clay-heap, only leaving just room for the horse to work the mill, and the other end near the kiln. Attention to this matter saves future labour, and therefore money.

"4th Point. Construction of kilns.

"The form of the clay kiln is circular, 11 ft. in diameter, and 7 ft. high. It is wholly built of damp earth, rammed firmly together and plastered inside and out with loam. The earth to form the walls is dug out round the base, leaving a circular trench about 4 ft. wide and as many deep, into which the fire-holes of the kiln open. If wood be the fuel used, three fire-holes are sufficient; if coal, four will be needed. About 1,200 common bricks are wanted to build the fire-holes and flues; if coal is used, rather fewer bricks will be wanted, but then some iron bars are necessary—six bars to each fire-hole.

"The earthen walls are 4 ft. thick at the floor of the kiln, at 7 ft. high, and tapering to the thickness of 2 ft. at the top; this will determine the slope of the exterior face of the kiln. The inside of the wall is carried up perpendicularly, and the loam plastering inside becomes, after the first burning, like a brick wall. The kiln may be safely erected in March, or whenever the danger of injury

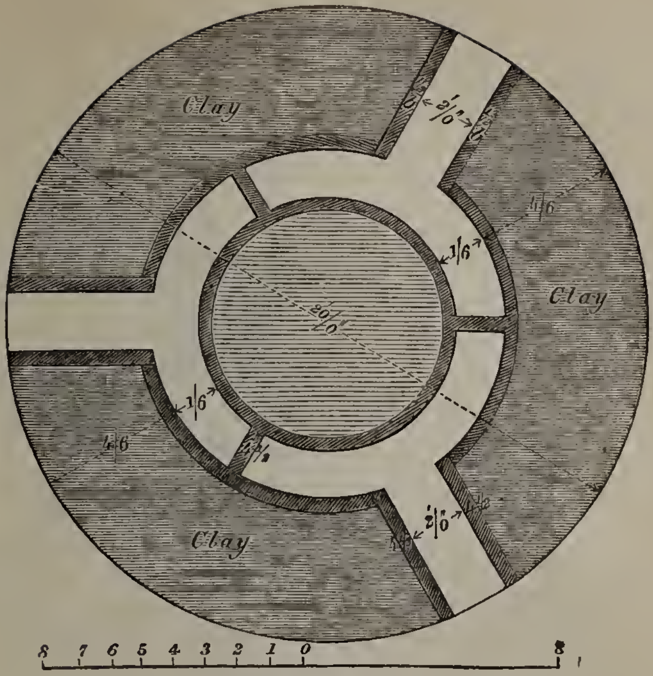


Fig. 1. *Plan of Kiln at* A B, *fig*. 3.

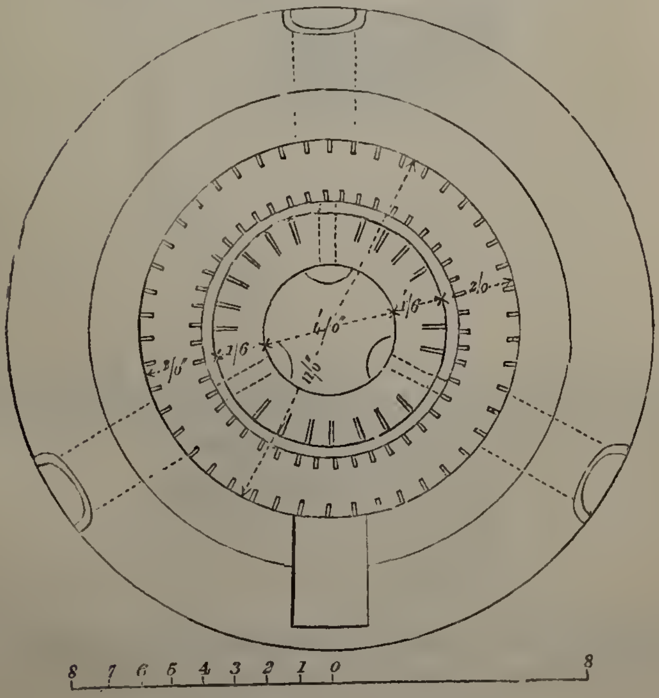
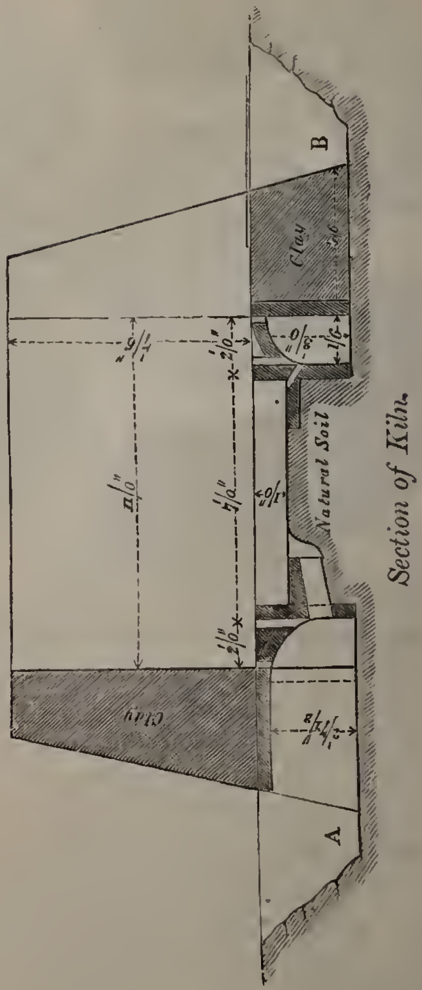


Fig. 2. *Plan of Top of Kiln*.

Fig. 3.



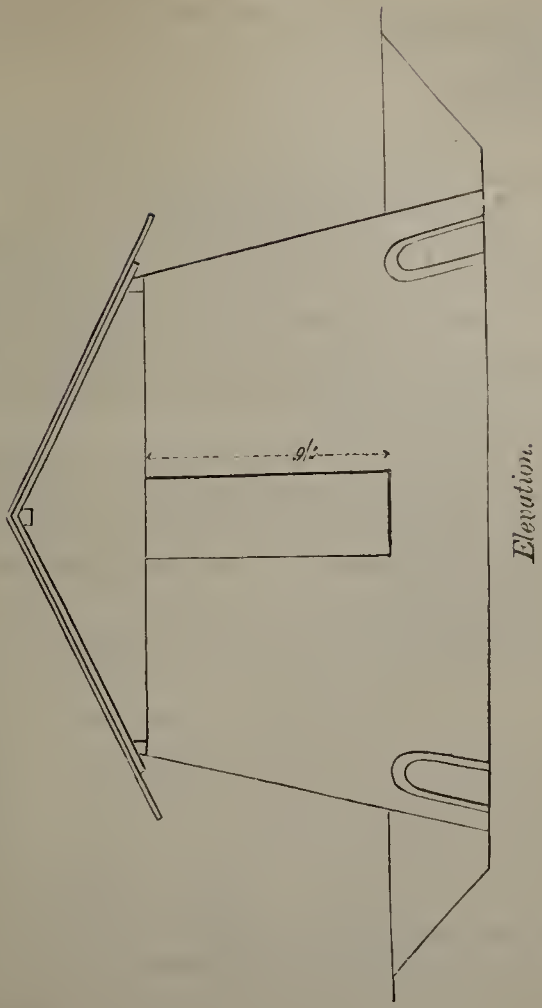
from frost is over. After the summer use of it, it must be protected by faggots or litter against the wet and the frost of winter.

"A kiln of these dimensions will contain—

47,000	1-in. bore pipe tiles.		
32,500	$1\frac{1}{4}$	,,	,,
20,000	$1\frac{3}{4}$	,,	,,
12,000	$2\frac{1}{4}$	,,	,,

and the last-mentioned size will hold the same number of the inch pipes inside of them, making therefore 24,000 of both sizes. In good

Fig. 4.



weather this kiln can be filled, burnt, and discharged once every fortnight; and fifteen kilns may be obtained in a good season, producing—

705,000 1-in. pipe tiles.
Or 487,500 $1\frac{1}{4}$ „ „
Or 300,000 $1\frac{3}{4}$ „ „

and so on in proportion for other sizes.

"N.B.—If a kiln of larger diameter be built, there must be more fire-holes, and additional shed room.

"5th Point. Cost of forming the establishment.

The price charged by Messrs. Cottam and Hallen for the machine, with its complement of dies, is	£25
Price of pug-mill	10
Cost of erecting kiln	5
Cost of sheds, straw	10
	50

(The latter item presumes that the farmer has hurdles of his own.)

"6th Point. Cost of tiles when ready for sale.

"As this must necessarily vary with the cost of the fuel, rate of wages, easy or difficult clay for working, or other local peculiarities, I can only give the cost of tiles as I have ascertained it here according to our charges for fuel, wages, &c., &c. Our clay is strong, and has a mixture of stones in it, but the machine is adapted for working any clay when properly prepared.

"It requires 2 tons 5 cwt. of good coals to burn the above kiln full of tiles. Coals are charged here at £1 8*s.* per ton, or 1,000 brush faggots will effect the same purpose, and cost the same money; of course some clays require more burning than others; the stronger the clay the less fuel required.

"The cost of making, the sale prices, and number of each sort that a waggon with four horses will carry, are as follows:—

	Cost. *s.*	*d.*		Sale Price. *s.*	Waggon holds—
1-in. pipe tiles	4	9	per 1,000	12	8,000
$1\frac{1}{4}$ "	6	0	"	14	7,000
$1\frac{3}{4}$ "	8	0	"	16	5,000
$2\frac{1}{4}$ "	10	0	"	20	3,500
$2\frac{3}{4}$ "	12	0	"	24	3,000
Elliptical tiles				24	2,000
Soles				10	2,000

"All these tiles exceed a foot in length when burnt.

"The cost price alone of making draining tiles will be the charge to every person making his *own* tiles for his *own* use. If he sell them, a higher price must, of course, be demanded to allow for some profit, for credit more or less long, for bad debts, goods unsold, &c. &c.; but he who makes his own saves all expense of carriage, and, as his outlay will not exceed £50, the interest on that sum is too trifling to be regarded, and he has no additional rent to pay; and after he has made as many tiles as he wants, his machine and pug-mill will be as good as ever, with reasonable care, and will fetch their value."

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THE END.

VIRTUE AND CO., PRINTERS, CITY ROAD, LONDON.

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